THURSDAY, NOVEMBER 27, 1884

OVER-PRESSURE IN ELEMENTARY SCHOOLS

THERE has lately arisen a warm controversy about over-pressure in schools, and its alleged results. The points in dispute are unquestionably important, and deserve the careful thought of all those who are interested in the intellectual and physical development of the rising generation. The cry of over pressure was raised some years ago with reference to middle-class schools, and during the discussion of the Proposals of the Education Department for the New Code it extended to elementary schools. The National Union of Elementary Teachers took up the subject at their meeting at Sheffield during the Easter week of 1882. In July they had an important conference with Members of Parliament at the House of Commons, and they have continued ever since to agitate for a relaxation of Government requirements. Their views were supported by the opinions of several medical men, and were gladly seized hold of by the opponents of the education of the people. The matter came before the Social Science Congress at Huddersfield and the Health Exhibition at South Kensington. It has been investigated and reported on by several School Boards. The *Times* has dealt with it in able leading articles, and the *Pall Mall* in prettily written "Idylls." The Education Department itself, and both Houses of Parliament, have been stirred by it, while the personal combat between Dr. Crichton Browne, one of the Lord Chancellor's Visitors, on the one side, and Mr. Fitch, one of the best known and most highly esteemed of Her Majesty's Inspectors, on the other, has added a flavour to the controversy.

The question is a large and complicated one. In dealing with it I have no intention of touching on any personal matters in dispute, nor of speaking of the pressure on School Board members, or on teachers. Our educational systems exist for the sake of the children, and must stand or fall according to the effect upon them. My remarks also will be restricted to public elementary schools, whether "voluntary" or "Board," though I do not believe that they are so open to the charge of over-pressure as many of our middle-class or higher schools.

The allegations are of the most serious order. It is not so much that here and there one poor child dies of disease brought on by over-work; but it is held that the bodies of our scholars are being systematically sacrificed to an abnormal development of their minds, and that there is growing up a generation whose nerves are over-strung, and who are becoming more and more liable to diseases of the brain and connected organs. The defenders of the present system, however, assert that these charges are enormously exaggerated, and that all reasonable precautions are taken against the occurrence of the evil.

In all this conflict it is difficult to find evidence of a scientific character; there is more rhetoric than argument, and even when the figures of speech are supplemented by statistics, the conclusions drawn from them seem open to question. There are, however, two conclusions which will scarcely be disputed by any one who has looked at the matter with any amount of impartiality.

(1) *That in all large schools there are children who are in danger of over-pressure.* Take the typical case of a class of seventy children, starting with about the same attainments. The bulk of these will be average boys, or girls, as the case may be, fairly healthy and intelligent, not given to over-much study, but still ready to fall in with the requirements of the school. But there will also be some half-starved children, who often come without any breakfast, dull children—descendants of a wholly uncultured race—feeble children, and others averse to any restraint and constitutionally irritable, together with children who are weary with toil at home, or with hanging about late at night, or working early in the morning before they go to school. Besides these there are the exceptionally clever children, who are in danger of under-pressure, and the over-sensitive or ambitious, who are prone to over-work themselves if allowed the opportunity. It is evident that the general scope of the instruction must be adapted to the average of the class. To reduce it to the level of the physically or mentally weak would be a cruel wrong to the majority of the children, and an injustice to the public, who, by means of taxes, rates, or voluntary contributions, mainly support the school.[1] But this insures the possibility of more being expected from some of the other boys or girls than they have the power to perform. This danger is aggravated where, as in many country parishes, it is difficult to raise sufficient funds to provide a proper staff and appliances for teaching, while the very existence of the school is dependent upon each child earning as large a Government grant as possible. The danger is aggravated also by the shocking irregularity with which those children attend who are driven in from the streets. Happily elementary schools are usually exempt from one prolific source of over-pressure—competitive examinations. The annual Government examination is simply for a pass, and is looked forward to with pleasure by the majority of the children.[2] The practice of the more important bodies of management is, I believe, similar in this respect to that of the London School Board, which recognises no competition between one child and another, unless it be for the Scripture prizes and a few scholarships, which it administers for other parties.

(2) *That in a large number of instances the circumstances of school life are more favourable to health than the home life.* Before the days of compulsory education many thousands of children passed a joyless existence shut up in close and often fetid rooms, or turned out in all weathers into the streets or alleys. Now these children are brought into warm, well-lighted, and well-ventilated school-rooms, where habits of cleanliness and self-respect are inculcated, and where both their bodies and minds are duly exercised. This is especially the case in the newly-constructed Board schools. It is difficult to show this improvement by statistics of health, but we have the statistics of death. The Registrar-General, having been applied to on this matter, reported that "the death-rate of children (from five to fifteen years of age) in 1861-70 was 6·3 per 1000. It fell in 1871-80 to 5·1 per

[1] So far from the majority of the children being over-pressed, it is admitted by Dr. Crichton Browne that 70 or 80 per cent. can accomplish the annual work required by the Code easily.

[2] An attendance-officer, formerly a schoolmaster, has just written to me as follows:—"I have ever found the children looking anxiously and joyously forward to the day of examination, so much so that it would be nothing short of absolute cruelty to deprive any of those dear little souls of their long-hoped-for privilege."

1000, a decline of 19·05 per cent." ; that "the main part in this fall was due to diminished mortality from the chief zymotic diseases" ; that death from other diseases had also declined, "whereas the death-rate from nervous affections remained unaffected," or, possibly, slightly increased. A diminution of 19 per cent. in the death-rate is a great gain, and that this is not to be wholly or mainly attributed to improved sanitary conditions in their dwellings is shown by the fact that the diminution of mortality is much smaller in children under the school age.[1] But the question arises, granted that going to school is in the main favourable to health, what about these nervous diseases? Is their probable increase the result of increased attendance at school during the last decade? Dr. Crichton Browne has drawn out and discussed at great length the statistics of lunacy and the mortality from hydrocephalus, cephalitis, diabetes, nephritis, Bright's disease, uræmia, rheumatic fever, and rheumatism, and shows that during the five years 1876-80 there was an increase of these diseases. But the remarkable fact comes out that this increase has affected all ages. The increase of death from diseases of the kidneys has been greater among persons of twenty years and upwards, and the increase from inflammation of the brain and its membranes has been greater among children under five years of age than among those who have attended school during the period in question.

But the statistics of disease would be more valuable than those of death. Unfortunately they scarcely exist. Dr. Crichton Browne has, however, tabulated the results of his inquiries on this subject in eleven London schools. In regard to headache, to which he has naturally paid great attention, he has arrived at the startling conclusion that "as many as 46·1 per cent. of the children attending elementary schools suffer from habitual headache." He analyses the nature of these headaches very fully, but to ask a class of children to hold up their hands in response to the question, "How many boys or girls here suffer from headaches often, or now and then?" is far from being a scientific method of procedure. His tables of comparison between the different Standards seem to me more valuable as evidence. If any real mischief is going on in our schools, it will betray itself in the evil being more apparent among those children who have been longest at school. In the case of short-sightedness, which, from investigations on the Continent, Mr. Brudenell Carter's inquiries at home, and other sources of information, we know to be a growing malady, the increasing percentage from Standard I. to Standard VI. is very apparent from Dr. Browne's table, rising, as it does, from 2·5 to 9·2. In the case of headache there is a slight increase; but in the case of sleeplessness and neuralgia or toothache there is a very marked decrease. No doubt the inquiry is a very complex one, and it is impossible to separate the different factors in the result, but these tables certainly invalidate rather than support the opinion that the nervous systems of the children in our primary schools are being seriously undermined.

In so important a matter as the health of the rising generation we should welcome any additional knowledge that may be the outcome of this controversy; but the point of practical importance is how to maintain to the utmost the beneficial results of our educational system, and at the same time avoid the danger of over-pressure in individual instances or under specially unfavourable circumstances.

The provisions of the Mundella Code and the recent Instructions to Her Majesty's Inspectors ought to be fully carried out. In Article 8 of the Code managers are stated to be held responsible "for the care of the health of individual scholars, who may need to be withheld from examination or relieved from some part of the school work throughout the year." In Article 109 it is stated: "The inspector will also satisfy himself that the teacher has neither withheld scholars improperly from examination, nor unduly pressed those who are dull or delicate in preparation for it at any time of the year; and that, in classifying them for instruction, regard has been paid to their health, their age, and their mental capacity, as well as to their due progress in learning." The local managers are also considered the best judges of the special circumstances which render it inexpedient to require home lessons. But how are managers to judge of the health of individual children? The proposal that a monthly record of the height, weight, head and chest girth of all the children should be kept in every school is not likely to be adopted, on account of the enormous additional expense which it would entail; but it would not seem impracticable to draw up some simple regulations for teachers or managers which might enable them to detect an anæmic or neurotic condition or the incipient stages of nervous malady.

A guard ought to be set against those practices which tend to over-pressure. These are pretty well known to practical teachers. The London Board has during the last two or three years taken several steps in this direction. The teachers used to be paid partly from the Government grant, and thus had a pecuniary incentive to press forward the feeble, so as to insure their passing the examination. There were great difficulties in altering these arrangements, but it was accomplished at the close of last year. It is a common practice to prolong the hours of teaching, especially shortly before the inspector's visit; this was objected to by the London Board four years ago, and now is forbidden. Home lessons are left optional with the teachers and the parents. Improved physical exercises for girls have been introduced. The Education Department has been induced to diminish the excessive requirements of the Code in regard to needlework. Arrangements also are being made for relieving the pupil-teachers to a large extent from their labours in the schools.

It is to be hoped that one beneficial result of this discussion will be an increased perception of the necessity of variety in the subjects of instruction. In the words of Mr. E. N. Buxton, Chairman of the London Board, "It is monotony which kills; indeed, we look to a wholesome variety as a means of welcome relief." Happily the Code now requires "varied and appropriate occupations in infant schools;" and this is largely insisted on in the recent Instructions to Her Majesty's Inspectors. The dreary monotony of the three R's in the 1st Standard and in backward schools should be relieved by object-lessons or other interesting occupations, and literary studies should be balanced by the elements of science as well as by drawing,

[1] This matter is discussed in the *Statistical Journal* for June 1883 and June 1884.

singing, drill, and cookery or handicraft. It is a matter of common experience that whatever increases the vigour or quickens the intelligence of children enables them to acquire book-learning in a much shorter space of time. In whatever points educationists may differ, there will be a general agreement that the bodily senses of our young working-class population ought to be developed as well as their mental faculties, and that it is highly important for them at least to know something of the world in which they live and of the materials and natural forces with which they work.

J. H. GLADSTONE

THE DISTRIBUTION OF THE METEOROLOGICAL ELEMENTS IN CYCLONES AND ANTICYCLONES

Sur la Distribution des Éléments Météorologiques autour des Minima et des Maxima Barométriques. Par H. Hildebrand Hildebrandsson. Présenté à la Société Royale des Sciences d'Upsal le 10 Mars, 1883. (Upsal, 1883.)

WITH the publication of the first synoptic weather-maps in Europe and America about the middle of the present century, the scientific study of the great movements of the atmosphere and other phenomena of weather may be considered as having commenced. This method of inquiry soon taught us that in different parts of one and the same barometric depression or cyclone, very different climatic conditions prevailed. In the front part of the depression the weather is warm, moist, and clouded, whilst in the rear it is cold, dry, and clear. Further inquiry showed equally distinct types of weather characterising different parts of high-pressure areas or anticyclones. So close indeed are these relations that the study of weather resolves itself very much into an examination of the phenomena attending cyclones and anticyclones. If we could certainly prognose the distribution of atmospheric pressure over North-Western Europe on, say, Saturday next, we could for the same time forecast pretty correctly the weather over this part of the earth. Similarly, if we could forecast that the easterly tracks of the cyclones of the coming winter were to be south of the Channel, we could forecast a severe winter for the British Islands; and on the other hand if the path taken by these cyclones would be to the north of these islands, an unusually mild winter would certainly follow. Hence the supreme importance of any accession to our knowledge respecting cyclones and anticyclones. This is what Prof. Hildebrandsson's laborious and able paper does in various directions.

The direction and velocity of the wind as noted at Upsala at the surface of the earth, in the region of the lower clouds, and in the higher region of the cirrus, the temperature of the air, the amount of cloud, the frequency of rain, the transparency of the air, and the occurrence of fog are examined with reference to forty-three different sections or areas into which the author has partitioned cyclonic and anticyclonic systems according to the direction of the barometric gradient and the height of the barometer, three of these forty-three sections being the central areas of the cyclone and the anticyclone, and the space separating two cyclones which are not far apart.

As regards the direction of the wind it is shown that the angle made by the wind with the barometric gradient is greater in summer than in winter; greater at stations near the sea than at inland places; greater in cyclonic than in anticyclonic regions; and that the angle is the maximum, or the wind approximates most nearly to a circular course, when the gradient is directed towards the east, and the minimum when directed towards the west. The angle obtained for Upsala, which is nearly 50°, is greater than that obtained by Loomis for the United States, but less than what Mohn has found for Norway and Clement Ley for the British Islands. The observations made on three small islands were also examined, viz. Utklippan, a little to the south of Karlskrona, Wäderöbod, north-east of Jutland and a few miles off the Swedish coast, and Sandön, a low sand-bank about thirty-four miles north of Gothland, at which stations the angles are respectively 64°, 65°, and 74°. Here the influence of the sea on the angle made by the wind with the gradient is very striking, being about a half more at the strictly insular position of Sandön than at Upsala.

The angle is at the maximum in the three islands when the gradient is directed towards the east, and the minimum when directed towards the west, as at Upsala, and as Clement Ley has shown for England, Hoffmeyer for Denmark, and Spindler for Russia. One remarkable result is, however, shown with reference to each of the three islands, viz. the angle shows a well-pronounced secondary maximum when the gradient is directed towards the north-west. It is premature to attempt an explanation of the different degrees of the incurving of the wind upon the centre in the different parts of a cyclone, until similar results have been worked out for a large number of well-selected individual stations, and until a more definite knowledge is arrived at regarding the relative prevalence of ascending and descending aërial currents in the different sections of the cyclone and anticyclone.

The velocity of the wind is the minimum near the centres of cyclones and anticyclones, and in the middle space between the cyclones. From the central region of the anticyclone, the velocity of the wind increases as the barometer falls, and the maximum velocity is reached on approaching the calm central region of the cyclone. With respect to the gradients, the greatest velocity appears to occur when the gradient is directed towards the north and the least when the gradient is towards the west or the south-west.

In the region of the lower clouds, the wind takes a direction to the right of that of the wind at the surface of the earth. In other words, at this height the winds tend to follow the course of the isobars drawn for the sea-level pressure, with however two noteworthy exceptions. When the gradient is directed towards the west, the angle exceeds 90°; but when directed towards the south or south-east, it is markedly less than 90°.

In the higher region of the cirrus clouds, the winds blow centrifugally from the region of the cyclone towards that of the anticyclone. The velocity is least in the vicinity of the central region of the cyclone, but it steadily increases as it approaches and flows over the region of the anticyclone. The centrifugal movement is greater in

the front than in the rear of a cyclone, where indeed the motion of the cirrus cloud approaches the direction of the lower clouds and of the wind at the surface of the earth. The direction of the cirrus immediately behind and over the centre of depression is in Sweden generally from north or west, but, from the exceptions which occur, it is evident that more observations and discussions of the results are required.

Fog is of most frequent occurrence when the gradient is directed towards the north and least frequent when directed towards the south. In the Kattegat, fog attains its maximum frequency in the region situated between the lowest and the highest pressures. At Upsala the clearness of the air is nearly independent of barometric pressure, there being, however, a greater tendency to mistiness in the air when the gradient is directed towards the west than other directions. Cloud and rain are most frequent with gradients to the south or west, and least with gradients to the north-east. In summer, they regularly diminish as pressure increases; but in winter, less regularly, inasmuch as the strato-cumulus, which are the most common clouds in this season, are most numerous in times of high pressure and occasionally bring with them slight showers of snow.

In winter, temperature is above the mean both in cyclones and anticyclones when the gradient is directed towards the west, and below it when directed towards the east. In the same season, temperature rises on all sides towards the centre of the cyclone; in other words, the thermometer rises as the barometer falls, and *vice versâ*. In winter also temperature is ordinarily above the mean in cyclones, but under it in anticyclones and in the region between two cyclones; in summer the reverse holds good—these results being due to the different effects of solar and terrestrial radiation in these seasons.

With reference to the distribution of temperature with height, Hildebrandsson has examined the observations made at the Puy-de-Dôme and at Clermont Ferrand, near the base of the mountain in connection with the cyclones and anticyclones in that part of Europe during 1877-82. The difference between the temperatures of the two places in winter attains the maximum in the vicinity of the centre of a cyclone, and the difference diminishes according as the barometer rises, and the minimum is reached near the centre of the anticyclone, where temperature on the mean is higher at the higher station, the difference in height being 3516 feet. In such investigations, this high-level station, as well as the high-level stations in the south of France, in Switzerland, and Austria, have the disadvantage of being almost always on the north-west slope of anticyclonic areas, the centres of which are situated in a south-westerly direction. It is on rare occasions that well-marked cyclones cross these stations, and still rarer that cyclones pass to the south-west of them. Prof. Hildebrandsson states his opinion that, for the prosecution of these all-important researches, Ben Nevis, with its low- and high-level stations, occupies what is, perhaps, the most favourable position in the world, seeing that it is situated in the track of the greater part of the Atlantic storms which sweep over North-Western Europe, and that the publication of the observations *in extenso* would be an important gain to science.

"FLATLAND"

Flatland: a Romance of Many Dimensions. With Illustrations by the Author, A Square. (London: Seeley and Co., 1884.)

WE live in an age of adventure. Men are ready to join in expeditions to the North Pole or to the interior of the African continent, yet we will venture to say that the work before us describes a vast plain as yet untrodden by any Fellow of the Royal Geographical Society, and teeming with a population of which no example has figured in any of our shows. A few years ago a distinguished mathematician published some speculations on the existence of a book-worm "cabin'd, cribb'd, confin'd" within the narrow limits of an ordinary sheet of paper, and another writer bewailed "the dreary infinities of homoloidal space." A third remarks, "there is no logical impossibility in conceiving the existence of intelligent beings, living on and moving along the surface of any solid body, who are able to perceive nothing but what exists on this surface and insensible to all beyond it." How delighted Prof. Helmholtz will be to find, if this Flatland writer is worthy of credence, his conjecture thus verified. "Flatland" is not the real name of this unknown land (that secret is not divulged), but it is so called here to make its character clear to us Space-denizens. It is a noteworthy fact that one at least of the Flatlanders expresses himself in remarkably correct English, and singularly after the manner of an ordinary Space-human being; and further, though—we regret to have to record it—as a martyr in the cause of the truth of a third dimension, he has spent seven long years in the State jail, yet these memoirs have in some mysterious manner found their way into our hands. There is hope then that some one of our readers may yet expatiate in the broad plain, though the penalty will be, we fear, that he must first become as flat as a pancake and then see to it that his configuration (as a triangle, square, or other figure) is regular. This latter is a *sine quâ non* in Flatland, because, whatever you are, your configuration must be regular, or woe betide you, and you will shuffle off your mortal coil incontinently.

We will not stop to inquire how this and that have come about, but will endeavour to lay before our readers some of the features of this (to us) new world, though we are informed that it has just entered upon its third millennium.[1]

In Flatland there is no sun nor any light to make shadows, but there is fog. This, which we on this earth consider to be an unmitigated nuisance, is recognised in that other world "as a blessing scarcely inferior to air itself, and as the Nurse of Arts and Parent of Sciences." If there were no fog, all lines would be equally distinct, whereas under present circumstances, "by careful and constant experimental observation of comparative dimness and clearness, we are enabled to infer with great exactness the configuration of the object observed." It is a necessity of Flatland life to know the north (for instance, it is a point of good breeding to give a lady the north side of the way); this is determined in the absence

[1] From the secret Archives it appears that at the commencement of each millennium a Sphere descended into the midst of the Council of Circles proclaiming the great truth for the attempted teaching of which our author is in bonds.

of any heavenly bodies by a novel (we speak as a Space-denizen) law of Nature, viz. the constancy of an attraction to the south: however, in temperate regions the southward attraction is scarcely felt, but here again Nature comes to the Flatlander's aid. If he is in an inhabited region, the fact that the houses (mostly regular pentagons; squares and triangles are only allowed in the case of powder-magazines, barracks, and such like, for sufficient reasons) have their roofs towards the north, so that the rain, which always comes from that quarter, may run off and not damage the houses, will help him to get his north point. If, however, he is out in the country far away from trees and houses, there is no help for him until a shower of rain comes. We must now give some description of the inhabitants. The women are all straight lines; the men are other regular figures (if there be hopeless irregularity, which the hospitals cannot cure, then the man is put to death). The lowest orders, policemen, soldiers, and the *canaille*, are isosceles triangles, their mental calibre being determined by the largeness or smallness of the vertical angle. It is possible for an isosceles triangle to be developed into an equilateral triangle, or the offspring after a few generations may be so developed: in this class are the respectable tradesmen. The professional men and gentlemen are Squares—our author is a lawyer—and Pentagons. The Circles (that is, approximations more or less closely to that figure) are the nobility.

Another law of Nature in Flatland is that "a male child shall have one more side than his father, so that each generation shall rise (as a rule) one step in the scale of development and nobility." Our author, as appears by the drawing on the cover, has four pentagonal sons and two hexagonal grandsons. We do not clearly gather where the one eye (for Flatlanders appear to be monoculi) is situated, and how locomotion is effected we are not told. It can hardly be by such means as were once suggested by Prof. Clerk Maxwell, for in Flatland you must go steadily forward or dire may be the disaster you will inflict upon your neighbour. There seems to be no lack of Board schools, and there is at least one university, that of Wentbridge (we had by force of habit written Cambridge), where instruction is given in mathematics. A knowledge of this branch of study is obligatory, for since a Flatlander's eye can only move in his world-plane, all the objects, human and otherwise, even the circular priests, appear to be straight lines, and the figure-angles have to be, at any rate approximately, correctly guessed at sight.

Before we close our notice we must return to the description of the womankind. The women we have said are straight lines, hence they are very formidable, for they are like needles, and what makes them more to be dreaded is that they have the power of making themselves practically invisible, hence a Flatland female is "a creature by no means to be trifled with." There are, however, certain regulations in force which diminish the dangers resulting from having a woman about the house. There is an entrance for her on the eastern side of the house, by which she must enter "in a becoming and respectful manner"; she must also, when walking, keep up her peace-cry, under penalty of death, and if she has fits, is given to sneezing, or in any way is liable to any sudden movement, there is but one cure for such movements, and that is instant destruction. Though involuntary and sudden motions are thus summarily dealt with, yet if she is in any public place she must keep up a gentle "back-motion," and thus she is less liable to be invisible to her neighbours. Happily fashion exercises its potent sway in Flatland female society, as elsewhere, for we learn that "the rhythmical, and, if I may so say, well-modulated undulation of the back in our ladies of circular rank is envied and imitated by the wife of a common Equilateral, who can achieve nothing beyond a mere monotonous swing, like the ticking of a pendulum." Owing to their unfortunate configuration they are inferior in all good qualities to the very lowest of the Isosceles, being entirely devoid of brain-power, and they have "neither reflection, judgment, nor forethought, and hardly any memory." This is but a poor account, but we must bear in mind that it is an *ex parte* description by a Square who may at some time have suffered a disappointment at the hands of a lady. We shall be glad (though we can hardly expect such a result)—now that tidings have come from this little-known country—if some female will favour us with her view of the state of matters in Flatland. At birth a female is about an inch long, a tall adult woman reaches to about a foot. The length of the sides of an adult male of every class may be said to be three feet or a little more.

The book consists of two parts—*This World, i.e.* of Flatland, in twelve sections, and *Other Worlds*, in ten sections. The whole is very cleverly worked out, and many passages descriptive of events in the past history of the country at times force upon one the thought that after all the book may have been compiled by a Space-denizen, and that he is quietly laughing in his sleeve and saying, "de te Fabula narratur." However this may be, Flatlander or Spacelander, there is a slip in the note on p. 64, and for "Flatland" should be read "Spaceland."

We commend "A Square's" book to any of our readers who have a leisure hour from severer studies, and we believe when they have read it they will say "the tenth part of the humour has not been suggested" by our description.[1]

R. TUCKER

OUR BOOK SHELF

The First Principles of Natural Philosophy. By W. T. Lynn, B.A., F.R.A.S. Second Edition. (London: Van Voorst, 1884.)

It is a little difficult to see what useful purpose is served by this work, or why a second edition should be called for, seeing that it is neither of the popular nor yet of the properly scientific order of text-book. Its modes of regarding and describing the facts of dynamics are antiquated and incorrect, and it is extremely barren in numerical illustrations of the kind most helpful to elementary students. The author begins by telling the reader that "a pulling force takes the name of a tension," whilst "a pushing force" takes "that of a thrust." He then gives in abbreviated form Duchayla's proof of the parallelogram of forces, "because it is the foundation of the whole theory of statics," in spite of its essential faultiness in requiring more assumptions in the course of the argument than if the simple rule of compo-

[1] We may mention as specially humorous the chapters in which the Square is initiated into some of the mysteries of tri-dimensional space by the spherical stranger.

sition of vectors were assumed outright. The author is probably now the only surviving writer on dynamics who persists in muddling up force and acceleration by calling acceleration (a purely kinematical quantity in itself) an "accelerating force," and he adds to the muddle by writing $v = ft$ where all modern writers would put $v = at$. What the student is to understand by "a force capable of generating in one second a velocity represented by DE" (p. 27) is difficult to see, when the mass on which the force is to act is nowhere stated, and when it is not even stated or hinted that there is any mass at all to be acted on. On p. 41 the author states that "in this country the ounce avoirdupois is so taken that one thousand of them will just balance a cubic foot of distilled water." This is not so, at least in *this* country, for the mass of the ounce depends on the standard pound, and this was established without any reference to a standard volume of water. The definition is wrong; the fact it states is a mere coincidence; and the coincidence itself is not exact: a cubic foot of water does *not* weigh 1000 ounces. On the same page the author tells the reader to ascertain with respect to a certain mass the velocity which "a given pressure or impulse" will impress upon it; "the mass being inversely proportional to this velocity." The confusion between *pressure*, which cannot be expressed except in terms of force divided by area, and *impulse*, which is expressed as force multiplied by time, is truly amazing. Is time the reciprocal of an area? Again, on page 42 the author is speaking of a certain force capable of sustaining a certain weight for one second of time, and he says "it would require twice as powerful a force to enable it to resist the action of gravity for two seconds, three times for three, and so on." This is news indeed. In the section on hydrostatics, no sooner has the student learned that a pressure of one pound per square inch is equal to 100 lbs. per 100 square inches, than he comes to such a statement as the following (p. 52): "The pressure therefore exerted by a mass of fluid upon the bottom of a vessel containing it is proportional to the area of the base," &c. Here the author jumps, without one word of warning to the student as to his change in the use of words, from using the word pressure in its proper sense of so many *pounds-per-square-inch*, to using the word in the sense of so many *pounds*, in which case it is no longer a "pressure" but a "force." It may be said perhaps that these things are but slips of the pen. Perhaps they are; but in a teacher who undertakes to write a text-book of "first principles" slips of such a kind are unpardonable. No such confusion of thought would be tolerated in the pupil who had read Wormell's "Dynamics," or Lodge's "Mechanics," or Maxwell's "Matter and Motion," or Thomson and Tait's lesser volume. If Mr. Lynn does not intend his text-book to be cast aside as worse than useless, he must at once correct blundering modes of thought that can only mislead the student.

Éléments de Mécanique, avec de nombreux Exercices. Par F. I. C. Pp. 282. (Paris: Poussielgue Frères.)

THIS is the concluding volume of a series of elementary class-books on pure and applied mathematics issued by l'Institut des Frères Écoles chrétiennes, a French Society which showed in the Technical Schools at the recent Health Exhibition a noteworthy collection of specimens of work done in their schools, along with the educational apparatus used therein.

The character of the book before us harmonises with the evident sympathy of the Society with the manufacturing industries of the districts in which their schools are situated. We are furnished with an introduction to applied as well as to theoretical mechanics. There are good diagrams and descriptions of weighing-machines, cranes, and other lifting-tackle in the section on statics; the longest chapter in kinematics is concerned with the simpler forms of mechanism; and in dynamics there is a full discussion of the principle of work and its application to mechanics.

The text is clear, as far as it goes; but we think the general exposition of the theory too concise, many important points being relegated to the exercises at the end of each chapter.

There is a good collection of problems filling the last fifty pages of the book, but no examples are worked out in the text, and there are no results given to any of the exercises. Clearly, pupils using the book would require a good teacher at hand, who could devote ample time to the subject.

We should wish to see a book like this with a few select students, but, having regard to general class instruction, we do not think the mode of treatment a happy one. We feel called upon, however, to give a cordial recognition to the expansion in the direction of technical instruction, to the liberal supply of good diagrams, and to much freshness of treatment, both in text and examples, in the work before us. A. R. W.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Chemical Research in Great Britain

AT the anniversary meeting of the Chemical Society held March 31, 1884, the President read an address to the Fellows, which contains a series of remarks upon the prosecution of original research in England requiring some notice, particularly as a separate issue of the address has been circulated by the author. Attention is directed to the fact that we have an increased number of laboratories in Great Britain[1] and greater facilities for the prosecution of research through the aid of the Government grant and the Chemical Society's fund. Notwithstanding this the startling and anomalous fact is to be observed that the number of papers read before the Society is declining year by year.

After speaking in terms of praise of the degree of Doctor of Philosophy of Germany, which necessitates the prosecution of some original investigation, there follow some remarks which read like a serious reflection on a number of professors who have won distinction through unremunerative devotion to scientific teaching and research.

"The past neglect of research will, it is to be feared, have a more lasting influence on the progress of chemistry in this country than may appear at first sight, and in this way. Those who have been students in laboratories where the importance of this kind of work is not recognised, advance in their positions, becoming assistant demonstrators, &c., and eventually professors, and as they have not learnt to practically realise the value of research by being in the habit of conducting it themselves, or of seeing others do so, when they become professors they will naturally not encourage students to undertake it in their laboratories, and it is to be feared that we are already suffering in this way, and that this is one of the causes why the new laboratories which have been opened are doing so little to add to our store of fresh knowledge."

It will be questioned whether such a statement can be justified when it is mentioned that there happens to be lying on the table before the writer four reprints of papers recently received from the respective Professors of Chemistry in four of the new colleges; three of these memoirs are published in the *Philosophical Transactions* of the Royal Society, while a fifth occupant of one of the newly created chairs not long since received the Longstaff Medal. The whole subject seems scarcely to have been so well considered as to lead to a just appreciation of the cir-

[1] The term used is the United Kingdom, which includes Ireland. There has been no increase in the number of laboratories in Ireland, and only an increase of one in Scotland.

cumstances which give rise to unfavourable comparisons between scientific work in Great Britain and on the Continent.

But let us deal with the decline in the number of contributions to the Chemical Society. In 1880-81 there were 113 communications; in 1881-82, 87; in 1882-83, 70; and in 1883-84, 67. To what may this decline be assignable? In the first place the Chemical Society is not the only body in the United Kingdom which publishes papers on chemistry; there are the Royal Society of London, the Royal Society of Edinburgh, and five others, including the important Society of Chemical Industry. There are two societies in Dublin, but in this discussion Ireland will be left entirely out of the question. Causes not easily definable may lead to the transfer of authors' works to one or other of these bodies instead of to the Chemical Society. In fact these figures inform us that as the Society of Chemical Industry sprang into being and increased in importance so did the number of contributions to the Chemical Society diminish, and those to the younger body increase. We find that in 1883-84, the second year of its existence, there were sixty-eight papers read at the meetings of the Society of Chemical Industry, and the President will probably have to congratulate the members upon a still further increase at the next anniversary meeting. This is not all; the number of papers is no criterion of the excellence of the work done, and it may be maintained that the importance of the published communications has very distinctly increased, and if this be admitted it is self-evident that with increased elaboration, provided the same amount of work be expended, numerical decline must follow. In comparing the number of papers published in the *Transactions* of the Chemical Society with those in the Berlin *Berichte*, there is also an element of unjust reckoning, inasmuch as the latter volume includes the work of chemists not only distributed throughout the whole German Empire, but of many natives of eight other countries of Europe, occasionally a contingent from America, and even one or two from England. A strict examination will show that our shortcomings are scarcely so considerable as they appear from the President's representation.

Let us now consider what influence on original work may be expected from an increased number of laboratories and colleges. It is made to appear as if the fault which renders comparisons unfavourable to us lies entirely with the teachers. This is unwarrantable because, for the amount of instruction given, the proportion of professors and lecturers in Great Britain is much smaller than in Germany. Courses of lectures on theoretical chemistry—inorganic and organic—metallurgy, and applied chemistry, are not unusually required from one professor, who sometimes in addition is expected to lecture at night to artisans. In one or two cases he has to treat of physics, and is styled the Professor of Chemistry and Physics. Such labour would never fall to the lot of any German professor. For the sake of brevity all reference to the paucity and insufficiency of the endowment of the chairs may be omitted, as likewise the motives for study which influence the attendance in the new colleges.

It may well be doubted whether the President of the Chemical Society had earnestly sought to make himself acquainted with the course of instruction pursued in most English laboratories, and realised the difficulties in the prosecution of research by students which are known only to teachers. Medical students, for instance, pay their fees for a certain well-defined course of instruction, and always see that they get it. The lecturers and professors in other colleges, such as those recently established, would neglect their duty if they did not follow out the programme of studies drawn up by the respective Boards and Councils. The town councils, associations of manufacturers, and public-spirited gentlemen who establish the new colleges have been taught to believe that our manufactures and scientific industries are languishing for want of technical education, which must be supplied to masters, superintendents, foremen, and workmen. Their schemes of education are based on the requirements of such a class of students, and they are bound to comply with the demands made upon them. Hence it arises that a three years' course of study is devoted to mathematics, mechanics, drawing, physics, chemistry, and engineering. Chemistry in England is either a branch of general education, a professional, or a technical study, but seldom is it pursued for its own sake. From upwards of 1000 students taught in the laboratories of a single college during a period of nine years, only seven men can be counted who prosecuted their studies with any idea of making themselves chemists, and of these, five were the authors of researches pursued during their college career, which were published in the Chemical Society's *Journal*.

In the German Empire there are twenty-two Universities, all departments of the State, with professors, lecturers, demonstrators, assistants, buildings, and laboratory equipments provided and maintained by funds from the respective Governments. There are about two thousand teachers and twenty-five thousand students annually pursuing all branches of learning. Science, and experimental science especially, is valued to the same extent as classical and mathematical training in England; chemistry especially receives great attention, as is shown by the fact that the above figures include one hundred and twenty professors of chemistry, sixty of whom are "ordentliche Professoren." The cause of this has been attributed by some to the teachings of Liebig and those of his school. The result is that a student occupies himself with the most recondite branches of chemistry, physics, and cognate subjects, without having in view any immediate application of his knowledge or research either to the requirements of a professional career or those of a scientific industry. This is shown by the period spent at the University being longer than is necessary for such a purpose. Tradition has placed the learning of the schools of Oxford and Cambridge on a higher platform than that of science, and we cannot alter in thirty years that which has existed in men's minds for more than three centuries,[1] unless indeed we can call to our aid an intellect like that of Liebig placed in a position of great influence. It would, however, be a national misfortune if other branches of learning were to suffer for the benefit of science.

The recently-established colleges in the manufacturing districts differ from the Universities, and are more nearly allied to the special schools or Polytechnics of the Continent; but, in addition to providing the education of such establishments, they have to perform the functions of University colleges, of medical schools, and frequently also of superior mechanics' institutes, generally with a staff inadequate for the purpose. For the most part knowledge is acquired in such institutions only to serve as an aid to improving manufactures. There are on the Continent, not counting France, eleven Polytechnics, or high schools, built at a cost of not less than three millions sterling, and maintained by an annual expenditure of 200,000*l*. In "Les Allemands," by Le Père Didon, it is remarked that the prosperity of highly-cultivated nations depends upon the prosperity of the special schools and the Universities together, but there is a danger when the prosperity of the former leads to a decline in the popularity of the latter. In the work quoted, England is cited as an example of the inconveniences that arise from a want of equilibrium between professional education and the more theoretical and speculative teaching of the Universities. The dominating studies of classical literature, pure mathematics, philosophy, history, and theology of Oxford and Cambridge cause students of the middle class too frequently to pass at once to the professional colleges of medicine, engineering, &c., instead of educating professional men up to that level of general knowledge without which the most able specialist is wanting in a great essential to success in life.

That originality of thought is fostered and cultivated at the German Universities is an undoubted fact, but the requirements of the degree of Doctor of Philosophy cannot be entirely credited with this; it is rather that which is not required which is so advantageous to students. It is the *Lehre und lern Freiheit* which professors and pupils both enjoy; the professor has time for thought, and is not hampered by having to consider whether that which he teaches must be a suitable preparation for the pupils' various examinations, while the student, on the other hand, is not harassed by having to devote time and attention to uncongenial studies.

On the Continent the motive for scientific education is mental culture, while in Britain it is utilitarianism; while the former tends to the *advancement of learning*, the latter involves nothing further than the *diffusion of knowledge*. Hence the utilitarian principle neutralises in a great measure the advantages of an increased number of colleges, improved laboratories, and possibly of money-grants in aid of research.

The debased utilitarian view of the advantages of studying science is spread throughout the whole of this address, and it would be deplorable if all the presidents of the learned societies

[1] Bacon says ("Aphorisms," Book I. xc): "Again, in the habits and regulations of schools, universities, and the like assemblies, destined for the abode of learned men and the improvement of learning, everything is found to be opposed to the progress of the sciences.

preached an annual sermon from the same text. It is certain that the sympathies of the public would be alienated; and if those hearers who are taken to task were to follow consistently the lesson inculcated, they would occupy themselves entirely with objects of pecuniary gain instead of providing the discoveries which our manufacturers are so much in need of, or advancing learning by their contributions to the *Philosophical Transactions.*

W. N. HARTLEY

Our Future Watches and Clocks

IN reference to the note on this subject in NATURE (p. 36), it appears to me that to any radical change in dial-division there exist many objections, of more or less weight, over and above those already enumerated. In regard to—

(*A*) *Striking the hours.*—(1) It is said that "public clocks . . . could not go on to twenty-four." The same would apply to private clocks as well, as the higher numbers would be struck during the—to children and many others, sick or well—early hours of sleep, when greater disturbance from house clocks than at present occurs would be quite unendurable. The counter-advocacy of silent house clocks would scarcely meet the case.

(2) The alternative suggestion of "one stroke only at each hour" would do away with one important function of public clocks, that of marking to watchless people the exact hour. Persons abed, lonely watchers, and field-labourers, commonly depend upon the church clock for information which could only be acquired otherwise with much discomfort.

(*B*) *The 24-division plan.*—(3) That no diminution in "the angular motion of the hand" during any given time should be brought about seems most vital. The time of day is often obtained from far-distant clocks, and is even at present not easy to decipher readily, especially under circumstances of inadequate light or visual power.

(4) Similarly, in the case of any slight looseness in the hands—a commonly-neglected chronometric infirmity—it would be harder than ever to decide at a glance what hour is indicated.

(5) It will be observed that the adoption of this plan would almost necessitate half-minute arcs.

(*C*) *The double 12-division plan.*—(6) Inasmuch as the presence of two concentric circles of figures of undiminished size would shorten the clear effective length of the hands, the arc subtended by the hourly angle would be diminished by much the same extent as in the previous plan (*B* 3), and a similar objection would apply.

(7) The presence, in any form, of twenty-four symbols, in addition to the maker's name and the like, in the dial area, especially in ladies' time-pieces, would be eminently confusing, and restrictive of instantaneous decision as to what the time may be.

8. Even if, to obviate all this—a point suggested by the statement that "persons probably pay small attention to the figures"—a single circle of twelve conventional symbols, identical or not, such as a radial arrowhead, were adopted to indicate the a.m. and the p.m. hours in their turn, one would have to undergo the added mental labour of deciding the actual *number* of the hour.

(9) In any case the introduction of a "0" hour, unless we are to adopt railway phraseology, would be most awkward, and in the "double 12-division plan" the transition at noon and midnight from one circle to the other would not be a simple sequence.

Finally, the question arises whether the now common time-pieces, in which the hands are either replaced or supplemented by a series of peep-holes, wherein the minute, hour, and even week-day for the time being, are consecutively displayed, would not aid the introduction of the twenty-four hour system into rough general use. The main disadvantage of abolishing the hands is that one would lose an actual picture suggestive of the time which will elapse between the present and any point in the near future. For all purposes for which closer chronometric accuracy is required, the above stumbling-blocks to change in dial-division, arising out of the pressing value in ordinary life of the ability to tell the time swiftly, and without undue mental effort, would be swept away.

ERNEST G. HARMER

88, Buckingham Road, N., November 19

As regards the practical question how clocks are to be made to strike if the dial is to show twenty-four hours, I have a suggestion to make.

But firstly, the convenience of beginning the day at midnight is evident, as the early morning hours are those which it is most useful to have indicated to the ear, and our clocks may continue to strike from 1 a.m. to 6 as now.

The inconvenience of having to count any number of strokes above six is so great, and doing it so tedious, that most persons break down in attempting it with a slow-striking clock; and I think that there is a good deal to be said for the system, which obtains in some places where the hours are still reckoned as twenty-four, of beginning afresh at the end of every six hours, and denoting 7 and 13 as 1, &c. This plan would make very little or no change.

But what I wished to suggest is: That clock-makers should make the clocks to beat the strokes in pairs; *e.g.* two strokes and a rest + two strokes and a rest + one stroke, would be 5. This would be counted as easily as 3. Moreover, there would be no occasion under ordinary circumstances to count the strokes at all; whether the hour was *odd* or *even* would be all it was necessary to learn for one to know which hour it was of the twenty-four. One may, for instance, in the morning doubt whether it is 10 or 11, or whether it is 11 or 12, but one rarely doubts whether it is 10 or 12. And on the principle I recommend, the last stroke of the clock being single or double would decide the matter. One would not even have to attend to it. I contend that under the present system it is impossible for a person with only ordinary patience to discover whether a clock strikes 11 or 12.

If you think anything of this suggestion, which I have always thought myself to be a fair solution of a difficulty, I shall be glad if you would insert it in your paper.

R. B.

Lightning-Conductors

IN the *Edinburgh Review* of last July many of your readers will probably have noticed an article on "Lightning-Conductors," written somewhat strongly from the point of view of an advocate of the apparatus thus popularly designated. Perhaps a few words of comment on this paper from a rather different aspect may not be without interest to those who are able and willing to treat the subject with unprejudiced minds.

In the reviewer's narrative of the history of lightning-rods he omits all mention of Franklin's initial letter of September 1, 1747—that letter in which the great discovery of the power of points is given to the world. But it is abundantly evident from his subsequent letters of 1749 and 1750, in which he definitely forecasts the invention of rods, that it was to his knowledge of this power—and of this power alone—that he owed the idea of these instruments. In other words, his original conception was purely that of an apparatus for *preventing* the occurrence of a lightning-stroke at the place where the rod was erected. Now, if I am not mistaken, the reviewer from first to last never alludes to this all-important function. It is true that Franklin himself afterwards fell in with the curious supposition that these rods acted as "conductors" of a stroke. But (so far as can be judged from his letters) this was not till September 1753, at which time most of the European scientific men, themselves either ignorant or sceptical of the preventive power of points, had fully adopted the invention and had invested it with the theory, that has ever since been accepted, of its being a means of "conducting" past the building a stream of fiery matter (denoted as "electric fluid") descending from the clouds to the ground. Now it is evident that nothing can conduct the agency known by us as "lightning" without first being struck by it; and it is also manifest that, in order to be so struck, an object must present some "attraction" to the stroke. This attraction—this necessary first step to conduction—allowing for the nonce that an explosion such as constitutes a lightning-stroke *can* be conducted—is a matter that usually (and not unnaturally) is treated by those who believe in lightning-rods with some little reticence. I therefore think it is but fair to give credit to the reviewer for the open and honourable manner in which he enunciates his views of the true function of lightning-rods. He says (p. 40):—"Conductors provided by engineering art are *intended* to be struck, but struck in such a manner as to govern the lightning and to render the heaviest strokes harmless." There is no beating about the bush. He admits that his conductors are purposely fixed on a house in order to attract a stroke to that house with the view of afterwards rendering the effects of the explosion nugatory. Now the very essence of the opposition that has been made to the use of these conductors lies in this very fact of

attraction—and in one other fact, which is this. It is absolutely impossible to prove that *any stroke at all* would have occurred at the house if the attractive conductor had not been present. Granted, we (opponents) say, that your conductor, if in good order, *may* be the means of averting the terrific force of the explosion from the non-conducting materials of the building when once the stroke has been developed, we nevertheless prefer that our houses should receive *no stroke at all.* We infinitely prefer to run the extremely unlikely chance of ever being visited by a lightning-stroke to the practice of deliberately inviting such a stroke to our houses, and of trusting to the excellence of the rod-manufacturer's arrangements to avert any portion of its effects from the inmates and the structure.

Holding, then, as we do, that the principle of the lightning-rod, *quâ* its necessary exposure of additional elevated metal on a building, is vicious, and that nothing of a beneficial nature due to the preventive power of its point (if it have one) can obliterate this dangerous tendency, the undoubted disadvantages of the system, due to the defects in practice that habitually accompany the employment of rods, appear to be minor points. But the reviewer's reasoning on this branch of the subject is worthy of remark. He says (p. 52): "The failures incident upon defective work—as all unbiased and properly-trained thinkers are aware—are amongst the weightiest of the arguments that tell in favour of the employment of conductors." This sentence is wholly beyond my own reasoning power. Because (*cæteris paribus*) an apparatus is liable to failure on account of being defectively constructed, *therefore* it should be employed! He goes on to say:—"In a very large majority of the cases in which accidents have occurred to buildings which have been furnished with lightning-conductors the mischief has actually been traced by competent inquiry to some easily recognised fault or deficiency of construction." Allowing that even in *all* cases in which these disasters had occurred this statement were true, what does it show? Why, simply the very cheap sort of perception known as *wisdom after the event.* The manner in which, after the blow has happened, ingenious excuses are constantly made for the unfortunate conductors, which previous to the event had never been found fault with, is to the opponents of rods one of the most amusing and least edifying circumstances that environ the use of these instruments. But I would now venture to submit a few statistics derived from researches specially made by me during the last five years in regard to strokes and accidents in connection with lightning-rods. Up to date I have collected the fullest details of 320 well-authenticated cases. In 204 of these, or 64 *per cent.*, injuries either to rods, constructions, or persons, occurred. In 151 cases, or 47 *per cent.*, there were injuries either to constructions or to persons. Out of these 151 incidents, 71 contain in their records no allegations as to the existence of faults, either in the rod or in its "earth," until *after the event*, and the remaining 80 furnish no record of such faults being found *either before or after the event.* And indeed the whole of the results of my researches afford evidence (and especially in regard to the "earths" of rods) that failures and accidents more frequently happen with rods in what is deemed good order, than with those considered after the event to have been in bad order.

The reviewer in his enthusiastic advocacy of lightning-rods advises his followers not to be content with single, or even a few, rods on their houses, but to cover them with "a broadly-cast net of metallic meshes and lines." And he concludes with the following sentence:—"The free and frequent use of the testing galvanometer is the natural consummation of the beneficent work which was initiated by Franklin 130 years ago. Without this instrument the lightning-conductor is a hopeful and very generally helpful expedient. But with the galvanometer it is now assuredly competent to take rank as a *never-failing protection.*" These *dicta* aptly conform with the reviewer's tactics in respect of the practical question of the *cost* of lightning-conductors. Here again, as in the case of the preventive power of points, he never mentions the subject. He seems to think that persons of common sense are capable of throwing "a broadly-cast net of metallic meshes and lines" of the purest copper over their houses, and of entertaining at frequent intervals the services of electrical testers to attend to these meshes and lines, without first counting the cost. He is perhaps unaware that (according to Sir William Thomson) the Glasgow manufacturers think it cheaper to insure their factories rather than to employ lightning-rods. But surely in regard to the statement that the use of the galvanometer makes the lightning-conductor a "never-failing protection," there is some little obscurity in the premises and conclusions. It is well known that rod advocates recommend the use of the galvanometer principally in order to test the resistance of the rod's "earth." If this resistance should prove to be above a certain standard, they say that the rod is not only useless, but dangerous. How is the mere fact of the *knowledge* that a rod is useless, or that its earth-resistance is too great, a "never-failing protection"? And what remedial measures can possibly obviate the dryness of the ground? One might as well say that the services of a physician who, having tested his patient's state of health, should tell him that he was in a bad way, and should then dismiss him, constituted a "never-failing protection." In the case of the rod the only protective feature appears to me to lie in the probability that most persons who were also "unbiased and properly-trained thinkers," on being informed that the galvanometer had demonstrated their rods to have a too great "earth" resistance, would immediately pull them down. But obviously this is hardly the reviewer's meaning. ARTHUR PARNELL

53, Fulham Park Gardens, November 17

Government Scientific Books

SHORTLY after the commencement of the publication of the "Scientific Results of the Voyage of H.M.S. *Challenger*" by the Government, the late Mr. T. C. Cobbold, M.P. for Ipswich, inquired in the House of Commons whether, inasmuch as this expedition was undertaken with the nation's money for national scientific purposes, a copy of the volumes as published would not be presented to the public libraries supported by public rates, &c. The Government reply was that the expense of supplying the work gratis to such libraries in the different towns throughout the country would be too large.

I should like to ask whether it would have cost anything like the 87,500*l.* which the Government has recently paid for only two pictures from the Blenheim collection, and whether the ratepayers throughout the country have not a far greater right to be supplied (through their libraries) with the opportunity of seeing and studying the results of their own scientific expeditions than the remote opportunity of seeing these two 87,500*l.* paintings at Kensington.

I see by your advertisement that the tenth volume, at 50*s.*, of the "*Challenger* Reports" is just published. What chance have thousands like myself of ever seeing them. Our public museum library cannot afford to purchase them, though I have little doubt but that our town, with its 50,000 inhabitants, has more than paid for a copy of the Reports in its share towards the expense of the Expedition and the publications resulting therefrom.

As a country ratepayer I must protest against this centralisation of all the great works in art and the benefits and results of scientific expeditions in London. Some of your correspondents have complained that such *national publications* are not supplied to great national libraries abroad, but how is it that even we who have had to pay for them cannot ever get a sight of the results of such interesting and important national scientific expeditions. "Cannot afford it" is the Government reply, but how then can they afford 87,500*l.* for two paintings for the national galleries? I do not grudge the expenditure of the people's money for the latter, only when set off against the "cannot afford" for the former. W. BUDDEN

Ipswich, November 18

P.S.—I have the two volumes of Sir C. W. Thomson's "Voyage of the *Challenger*," but they have only tended to create a greater desire to see the complete "Government Reports," a wish, alas, which, from the expenditure of the 87,500*l.* for pictures by the Government, is further off than ever.

Peculiar Ice Forms

ABSENCE from town prevented me from seeing NATURE of November 6, in which there is a letter (p. 5) signed B. Woodd Smith with the above heading.

Possibly Mr. Smith's very ingenious explanation of the cause of the columnar form of the shallow stratum of ice he so well describes may be the correct one; yet perhaps I may be permitted to offer a very different solution of the difficulty connected with this very curious ice formation.

I have frequently noticed, both on lakes having deep water

and on those so shallow as to freeze to the bottom, that when the winter ice had nearly all thawed away, the remaining ice assumed the basaltic or columnar form, which on the deep-water lake could be walked over with perfect safety in the early-morning, being then perhaps six or eight inches thick, and apparently quite solid, but which all disappeared a few hours afterwards in a magical manner, the columns having become very rapidly detached, especially if there was a fresh breeze, and, falling over on their sides, became invisible, and drifted to the lee side of the lake. This often led to a very general but wholly erroneous belief that the ice had *sunk*.

The question may be very naturally put: What has all this to do with "peculiar ice forms" on dry land?

The foregoing particulars are mentioned to show that ice in wasting away assumes not unfrequently the basaltic form.

I believe that the bank on which the peculiar ice was noticed by Mr. Smith, and described by him as bare of vegetation, is usually covered in winter by a deep snowdrift, and that, towards spring and later, pressure and the percolation of water from the thawing surface converts the lower stratum of snow—still colder than the freezing-point—into ice. May not this ice, when nearly all wasted away, assume, as it does on the lakes, a basaltic structure?

May not the division of this four inches of ice "into four distinct layers—the columns of one layer being readily detached from those underneath"—be accounted for by what I have found to take place in snowdrifts, as I shall attempt to explain.

In building snow-huts there are two requisites essential for perfection in this kind of architecture. First, the snow has to be packed so firmly by the force of the wind as to be hard enough to walk over without sinking in it; secondly, the required depth of from fifteen to sixteen inches must be the formation of one and the same snowstorm and gale of wind. If this is not so, and the required depth of fifteen inches has been the result of three separate snowstorms, the blocks of snow, when sawn out, would not cohere, but break into three narrow strips of four or five inches each, which would render hut-building in the proper *artistic* manner and with rapidity (an important point in very cold weather) impossible.

These separate layers of ice noticed by Mr. Smith may possibly be the small remains of four separate and distinct snowstorms piled one above the other, which I know do—whilst in the form of snow—retain their individuality for the whole winter, although super-imposed the one upon the other.

The layer of "dirt" which Mr. Smith, from his point of view, very naturally supposes to be evidence that the mass of "peculiar ice" was pushed up from below, may be very easily otherwise accounted for.

In all gales with drifting snow in the Arctic, especially when there are high steep lands to be passed over, part of the ground is cut away by the driving snow in the form of fine powder or dust, and is carried sometimes a long way until deposited with the snow in some sheltered part.

This dust is small in quantity as compared with the bulk of snow, and is scarcely discernible when mingled with it; but when greater part of the snow melts, the dust shows as a very perceptible coat of "dirt" on the surface, which I consider has come down from above instead of being "pushed up from below" out of the ground as Mr. Smith believes to be the case.

4, Addison Gardens, Kensington, W. JOHN RAE

Fly-Maggots Feeding on Caterpillars

IN reply to Dr. Bonavia's note on the above subject in NATURE for November 13 (p. 29), I beg to inform him that the larvæ of the house-fly are often internally parasitic on the larvæ of Lepidoptera. I have bred them in large numbers from *Vanessa io* and *Saturnia carpini*, also from other species more sparingly. Nor is this the only species of Diptera that infests Lepidoptera. F. N. PIERCE

143, Smithdown Lane, Liverpool

Birds'-Nest Soup

IN NATURE of July 17 last (vol. xxx. p. 271), just received, appears an article on "Birds'-Nest Soup," which contains the statement that "the nests of the *bats*[1] and swifts were seen hanging in clusters from the sides and roof." That the addition of the "*bats*" to the contributors of the nests is not an accidental *lapsus calami* is shown further on, when we read that the visitor eating the soup will "at any rate have the satisfaction of knowing that he has before him a dish the principal ingredient of which was formed by the little swifts *and bats*[1] which inhabit the Gomanton Caves," &c., &c.

I too have visited caves from which large quantities of edible birds' nests were collected. I saw plenty of *bats*, but, unfortunately, none of their nests! The nests *I saw* were built by a "swiftlet" (*Collocalia*, Gray), and were more or less the *product of their own salivatory glands*. This fact was known as far back as 1781, over one hundred years ago!! The "*white nests*" are supplied entirely by the inspissated saliva of the bird, and are the first produced. These are taken, and sold for their weight in silver. The next made by the birds are mixed with rootlets, grasses, &c., and often show traces of blood, from the efforts of the birds to produce the saliva. These are esteemed second quality. The third nest is composed of extraneous substances cemented together and to the rock with a little saliva; these are generally left for the bird to breed in, and are usually destroyed at the end of the season to compel the birds to build fresh *white* ones after their powers are recruited by a year's rest and stimulated by the breeding "*storge*."

All this genus—the swiftlets (*Collocalia*)—wherever found, produce, in a greater or less degree, an amount of saliva which is used in building their nests and attaching them to the surfaces of rocks or the insides of hollow trees and leaves. The properties in this *saliva*—as in the *kava* of the Fijians and the *pepsine* of the calf—give it its value in the eyes of the Chinese. If it were simply a "fungoid growth" woven together, why is it not gathered from the limestone rock in its pure state?

British Consulate, September 17 E. L. LAYARD

[1] The italics are mine.—E. I. L.

THE PRIME MERIDIAN CONFERENCE

WE believe that the protocols of this Conference have not yet reached this country. In the meantime we are permitted to give the official statement of the resolutions.

FINAL ACT

The President of the United States of America, in pursuance of a special provision of Congress, having extended to the Governments of all nations in diplomatic relations with his own, an invitation to send Delegates to meet Delegates from the United States in the City of Washington on October 1, 1884, for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the world, this International Meridian Conference did assemble at the time and place designated; and, after careful and patient discussion, has passed the following resolutions:—

I. "*Resolved*, That it is the opinion of this Conference that it is desirable to adopt a single prime meridian for all nations, in place of the multiplicity of initial meridians which now exist."

This resolution was unanimously adopted.

II. "*Resolved*, That the Conference proposes to the Governments here represented the adoption of the meridian passing through the centre of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude."

The above resolution was adopted by the following vote:—

In the affirmative—

Austria-Hungary,	Mexico,
Chili,	Netherlands,
Colombia,	Paraguay,
Costa Rica,	Russia,
Germany,	Salvador,
Great Britain,	Spain,
Guatemala,	Sweden,
Hawaii,	Switzerland,
Italy,	Turkey,
Japan,	United States,
Liberia,	Venezuela.

In the negative—
San Domingo.

Abstaining from voting—
Brazil, France.

Ayes, 22; noes, 1; abstaining, 2.

III. "*Resolved*, That from this meridian longitude shall be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus."

This resolution was adopted by the following vote:—

In the affirmative—
Chili, Colombia, Costa Rica, Great Britain, Guatemala, Hawaii, Japan, Liberia, Mexico, Paraguay, Russia, Salvador, United States, Venezuela.

In the negative—
Italy, Netherlands, Spain, Sweden, Switzerland.

Abstaining from voting
Austria-Hungary, Brazil, France, Germany, San Domingo, Turkey.

Ayes, 14; noes, 5; abstaining, 6.

IV. "*Resolved*, That the Conference proposes the adoption of a universal day for all purposes for which it may be found convenient, and which shall not interfere with the use of local or other standard time where desirable."

This resolution was adopted by the following vote:—

In the affirmative—
Austria-Hungary, Brazil, Chili, Colombia, Costa Rica, France, Great Britain, Guatemala, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Paraguay, Russia, Salvador, Spain, Sweden, Switzerland, Turkey, United States, Venezuela.

Abstaining from voting—
Germany, San Domingo.

Ayes, 23; abstaining, 2.

V. "*Resolved*, That this universal day is to be a mean solar day; is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours."

This resolution was adopted by the following vote:—

In the affirmative—
Brazil, Chili, Colombia, Costa Rica, Great Britain, Guatemala, Hawaii, Japan, Liberia, Mexico, Paraguay, Russia, Turkey, United States, Venezuela.

In the negative—
Austria-Hungary, Spain.

Abstaining from voting—
France, Germany, Italy, Netherlands, San Domingo, Sweden, Switzerland.

Ayes, 15; noes, 2; abstaining, 7.

VI. "*Resolved*, That the Conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight."

This resolution was carried without division.

VII. "*Resolved*, That the Conference expresses the hope that the technical studies designed to regulate and extend the application of the decimal system to the division of angular space and of time shall be resumed, so as to permit the extension of this application to all cases in which it presents real advantages."

The motion was adopted by the following vote:—

In the affirmative—
Austria-Hungary, Brazil, Chili, Colombia, Costa Rica, France, Great Britain, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Paraguay, Russia, San Domingo, Spain, Switzerland, Turkey, United States, Venezuela.

Abstaining from voting—
Germany, Guatemala, Sweden.

Ayes, 21; abstaining, 3.

Done at Washington, October 22, 1884.

C. R. P. RODGERS, Rear-Admiral U.S.N., *President*,
L. CRULS (Brazil), JANSSEN (France), R. STRACHEY (Great Britain) . . . } *Secretaries*.

"*Resolved*, That a copy of the resolutions passed by this Conference shall be communicated to the Government of the United States of America, at whose instance and within whose territory the Conference has been convened."

ON THE INTERFERENCE-CURVES KNOWN AS "OHM'S FRINGES"

PERHAPS I may be allowed to recall the attention of physicists to the above "strange and interesting phenomena," as they are rightly called by their discoverer, Prof. G. S. Ohm (see *Pogg. Annalen* for 1853, vol. xc. p. 327); partly for the purpose of indicating a simple method of observing them.

According to Prof. Ohm's directions two plates of equal thickness are to be cut from a uniaxial crystal, with parallel surfaces making an angle of 45° with the optic axis. One of these plates is to be placed on the other in such a position that the optic axes lie in the same plane but on opposite sides of the normal common to the two plates, with which they make, of course, equal angles of 45°. When this combination is held in a convergent beam of plane-polarised monochromatic light (*e.g.* yellow sodium light), numerous alternations of bright and dark elliptical bands are seen, most distinctly when the plane containing the optic axes makes an angle of 45° with the plane of polarisation of the light.

Of course a pair of "Savart's band" plates, when properly oriented, will answer for the above experiment; but the peculiar double refraction of quartz causes more complicated but beautiful results.

Now, since in Iceland spar the optic axis makes an angle of very nearly 45° (strictly, 44° 36′) with the natural faces of the rhombohedron, all that is required is to obtain an even cleavage-plate of the spar, about 2 cm. × 1 cm. and about 2 mm. thick, to break it in half, to turn one of the pieces round in a plane parallel to its surfaces through an angle of 180° from its position when broken off, and to cement it on the other piece in this position with Canada balsam or dammar.

Then, on placing the combination in a polariscope (for instance, laying it on the eye-lens of a microscope with analyser just above it) the series of ellipses will be well seen. Sodium light, *e.g.* that from a Bunsen burner with a bead of sodium carbonate held in the flame, must be used.

Prof. Ohm refers to a paper by Langberg (which I have not been able to get a sight of) in which the occurrence and form of these bands were predicted from theory; so that the case resembles those of Airy's spirals and Hamilton's conical refraction.

A pair of plates with surfaces making an angle of 70° (or more) with the optic axis also show these ellipses; and perhaps more instructively, since with such plates it is easy to trace the origin of the bands in the coalescence of portions of the circular isochromatic bands of high order which surround the optic axis in each plate.

Those who have a pair of Savart's plates mounted so that one can rotate over the other, will find it most interesting and instructive to watch (in monochromatic light) the changes in form and character of the interference-bands as the azimuth of one of the plates is gradually altered.

Eton College H. G. MADAN

CONTINUOUS AUTOMATIC BRAKES

THE returns of the Railway Department of the Board of Trade serve as an excellent index to the defects in the management and working of the railway system in this country, the defects being brought to light during the investigations of the trivial casualties and disastrous accidents which take place, and inquired into by the experienced inspectors of the Board of Trade.

It is evident that by far the greater number of accidents seem to have been caused by the trains not being fitted with a really good brake, and in consequence being unable to stop quickly in cases of emergency. Some even have been caused by the brake itself failing to "go on" when required, caused either by some defect in the brake mechanism, or the design of the brake itself has been bad, giving the engine-driver a false sense of security, and leading the train with its living load into unnecessary danger.

It is a pity the railway companies do not pay more attention to the conditions laid down by the Board of Trade with regard to continuous brakes, stating the qualities the brake ought to possess, for it is evident the Board does not wish the adoption of any particular patentee's brake, but a brake which includes to the fullest extent the conditions laid down. It so happens that the Westinghouse automatic brake answers the conditions better than any other, and therefore the Board is anxious to see it in general use, not because an ex-inspector of the Board happens to be the chairman of the English Westinghouse Brake Company, as the secretary of one English railway seems to imagine, but because it is the best brake.

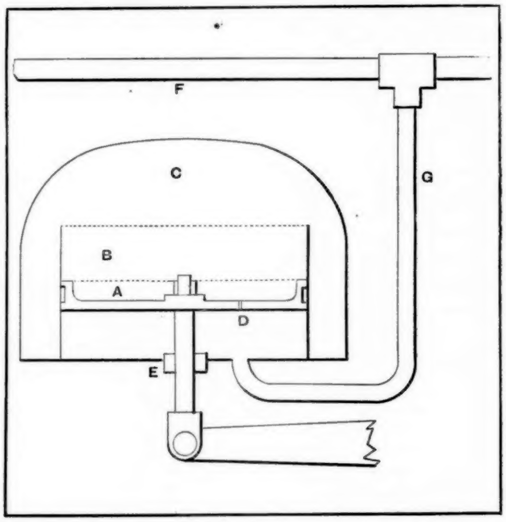
In an extract from the Board of Trade returns on continuous brakes for the half year ending June 30, published by the Vacuum Brake Company, we find the Westinghouse automatic credited with 397 faults for a mileage of 15,506,447.

We think it may be truly stated that the Westinghouse automatic has not had fair play with some of the companies having it partially in use, its failures having been carefully reported, while any failure of their own special brake, not having any serious consequences, has been looked over.

Take for instance the returns sent in by the Midland Company. Here the Westinghouse automatic has failed thirty-seven times for a mileage of 374,390, or one fault for every 10,118 miles, while the Midland automatic vacuum has six failures reported for a mileage of 5,245,573, or one fault for every 874,262 miles run. On the other hand we have the London, Brighton, and South Coast Railway using the Westinghouse automatic on the whole of their trains; they report seventy-four failures for a mileage of 3,122,510, or one fault for every 42,196 miles run.

Why should the Westinghouse automatic run four times as many miles per failure on the Brighton line than on the Midland? The reason is not far to seek; on the Brighton line the Westinghouse automatic is properly looked after, and kept in good repair, while on the Midland it has to stand back and give place to the vacuum automatic, the Company's brake.

The automatic vacuum brake in use on the Midland Railway has, as its name implies, the pressure of the atmosphere opposed to a partial vacuum for its motive



power, the vacuum being created by means of an ejector on the engine, connected to every vehicle on the train by means of a continuous pipe, having flexible pipes and couplings between the vehicles. To maintain the vacuum throughout the train against leakage, there is a small ejector continually in use on the engine.

Coupled to the continuous pipe on each vehicle is the automatic brake cylinder and reservoir peculiar to the Midland automatic brake, the piston being connected by means of levers and rods to the brake-blocks. The illustration gives a good idea of the general construction of the brake-cylinder and its connections, the arrangement being as follows:—The brake-cylinder B is placed inside the reservoir C, the piston A working air-tight in the cylinder; the piston-rod passing through the bottom of the cylinder by means of a gland, E, having a flexible packing ring, so arranged that when the piston is at the bottom of the cylinder it comes in contact with the packing ring, making an air-tight joint; but when the piston moves upwards, leaving the packing ring, air is able to pass through the gland into the lower part of the brake-cylinder. The continuous pipe F is connected by the branch pipe G to the lower part of the brake-cylinder.

Through the piston there is a small hole, D, called the leak-hole, this being one of the main features of the brake, the mode of action of which is as follows:—A vacuum is created in the continuous pipe by means of the ejector on the engine, the air being drawn from below the pistons in the brake-cylinder by the branch connections; the air in the reservoir C leaks through the leak hole D, and after a short time there is an equal vacuum above and below the pistons. The brake is now charged, and in its usual condition when the train is running, the vacuum being maintained against acccidental leakage by the continual use of the small ejector.

To apply the brake, air is admitted into the continuous pipe, destroying the partial vacuum, and, increasing the pressure below the pistons, causes them to rise, breaking at the same time the air-tight joint made by the piston against the packing ring, thereby admitting air *direct*, through the gland, into the lower part of the brake-cylinder, causing the application of the brakes to be nearly instantaneous. It will be observed that, directly the piston is forced up by the atmospheric pressure, the vacuum in the reservoir will gradually be destroyed by air passing through the leak-hole, in fact after less than two minutes it has leaked itself entirely off. It is also evident that it cannot be instantly charged, for the vacuum in the reservoir has to be created through the leak-hole.

It is stated by some that the Midland automatic vacuum answers all the Board of Trade conditions, and is therefore to be regarded as an effective serviceable automatic brake. On studying the reports in the returns, and the failures of this brake as reported in the technical papers, we see how absurd the claim to efficiency becomes. For example, the brake cannot be applied *quickly* several times in succession; when applied even once, the effective brake power has all vanished in two minutes, thus getting the doubtful name of the "two-minute leak-off brake." Again, suppose a train became divided from any cause, when ascending a heavy gradient, the brake should automatically apply itself, and *remain applied* until taken off by hand. What would the Midland automatic vacuum do under the above circumstances? Certainly the brake would apply itself, but in two minutes or less all the available brake power will have vanished, and, should the hand-brake in the rear van not prove powerful enough to hold the train on the bank, it will commence to run back.

Although the Midland Company have the automatic vacuum in general use, it is no criterion that the brake is satisfactory; we have only to add that the engines and tenders are fitted with an efficient steam brake, so that in entering stations, should the automatic vacuum fail, the steam brake is quite capable of stopping the train, only taking a little further distance to pull up in. At terminal stations sometimes this is very awkward, as the accident at the Liverpool Central Station, which happened some time ago, shows. Here the automatic vacuum brake failed, and the train ran into a brake-van standing by the stop-blocks, doing considerable damage. Reports of failures of the Midland automatic vacuum may be seen almost weekly in the "Railway Matters" column of the *Engineer*, and we give, as an example taken at random, one reported in the issue for October 17:—"As it is not very likely to be elsewhere recorded, it may be here mentioned that on the 10th inst. a twelve-coach Midland Scotch express ran clean through Bedford station before it was stopped, in consequence of the failure of the leak-off vacuum brake." Such failures are highly dangerous, and any brake with which they are likely to occur cannot be efficient, and therefore ought not to be trusted to stop trains at any important junction or station, and its use absolutely prohibited on approaching a terminal.

It may be interesting to have a short account of the Westinghouse automatic pressure brake, the worst fault of which, according to its opponents, is its efficiency in stopping trains should anything go wrong with the brake apparatus. The motive power of this brake is compressed air at a pressure of about 80 lbs. to 100 lbs., compressed by an ingeniously constructed steam-pump on the engine, and stored in a main reservoir under the foot-plate; throughout the train runs a pipe, connected between the vehicles by means of flexible hose pipes and couplings. On each vehicle, including the engine, is placed a small reservoir, a triple valve, and a brake cylinder, with a piston connected by levers and rods to the brake blocks. On the engine is placed the driver's brake-valve for working the brake. The whole system of this brake lies entirely in the construction and action of the triple valve. When the brake is in use, the train-pipe and small reservoirs are charged with compressed air, the air passing through the triple valve in its passage from the train-pipe to the small reservoirs. On the air-pressure being reduced, the triple valve opens a passage between the small reservoir and the brake-cylinder, thus allowing the compressed air stored to expand into the brake-cylinder, forcing out the piston, and applying the brake. To take the brake off, the converse happens: the pressure in the train-pipe is increased, the triple valve closing the passage between the small reservoir and the brake-cylinder, at the same time allowing the compressed air in the brake-cylinder to exhaust into the atmosphere, the small reservoir again being charged with compressed air from the train-pipe.

The triple valve consists of a small cylinder having a piston connected on the upper side to a small slide-valve working over two ports, arranged one about the other, the lower opening direct to the atmosphere, the upper connected by a pipe to the brake-cylinder. The slide-valve works in a small casing connected to the small reservoir; the triple valve is connected to the train-pipe by a pipe opening into the lower part of the cylinder in which the small piston works. When the piston is at the top of the cylinder it opens a connection between its lower and upper side, thus allowing compressed air to pass round the piston into the casing in which the slide-valve works, then into the small reservoir. When in this position, the slide-valve has closed both ports to the compressed air in the casing, the port leading to the brake-cylinder being open, through the valve, to the lower or exhaust port.

On charging the train-pipe with compressed air it will be observed that the piston in the triple valve will be forced up, thus filling the small reservoir and triple valve with compressed air, but *not* the brake-cylinder; also that the pressure of air on both sides of the piston in the triple valve will be equal; on reducing the air-pressure in the train-pipe by a few pounds, the piston will naturally be forced down, by the greater pressure on the upper side moving the slide-valve and allowing a quantity of the compressed air in the small reservoir to enter the port leading to the brake-cylinder, and apply the brake.

The air expanding into the brake-cylinder will cause its pressure to be reduced, and therefore balance the piston in the triple valve. It is evident therefore that any small reduction of pressure in the train-pipe will cause a corresponding application of the brake, a reduction of the pressure by 25 lbs. being sufficient to put the brake hard on and skid every wheel.

The function of the driver's brake-valve is to work the brake-apparatus by varying the pressure of the air in the train-pipe. In the first position of the handle which works the valve, called the charging position, air from the main reservoir is able to go direct to the train-pipe, to charge or release the brake. On moving the handle through an angle of a few degrees into the feed-position, the connection between the main reservoir and the train-pipe is closed, the compressed air having to pass through a pressure-reducing valve on its way to the train-pipe from the main reservoir to make up for any slight leakage which may occur.

It is important that the pressure of the air in the main

reservoir should always be about 15 lbs. above that in the train-pipe, so that when the brakes are being released by increasing the pressure in the train-pipe *direct* from the main reservoir, the triple valves are certain to act, on account of the extra 15 lbs. pressure in the train-pipe above the pressure in the small reservoirs.

On moving the handle of the driver's valve further in the same direction, or into the position for applying the brakes, all connection between the main reservoir and the train-pipe is cut off, at the same time that the train-pipe is put in connection with the atmosphere, through an exhaust port; by this means the pressure in the train-pipe can be reduced to any degree to apply the brake. All brake-cylinders on vehicles are fitted with a release-valve, so that, should the brake be applied when the engine is not attached, the air can be discharged from the brake-cylinder, through the release-valve, by pulling a wire attached to the valve.

All vehicles now fitted with this brake have cocks at each end of the train-pipe, so that, should any change have to be made in the train, the coupling or uncoupling of vehicles is easily accomplished without the brake automatically applying itself.

It is easy to see that this brake is automatic in its action, for should the train-pipe or flexible couplings be injured by accident, or the train part into two or more portions, the compressed air will escape from the train-pipe, and the brake will apply itself. In all guards' vans is placed a cock in connection with the train-pipe, so that, should the guard observe anything wrong with the train, or receive a signal from a passenger, he can instantaneously apply the brake by opening the cock and discharging the air from the train-pipe.

The Westinghouse automatic brake is at present the only one which really includes all the qualities in the Board of Trade requirements for continuous brakes, and perhaps it will not be out of place to state the requirements of the Board of Trade.

(1) The brakes to be efficient in stopping trains, instantaneous in their action, capable of being applied without difficulty by engine-drivers and guards.

(2) In cases of accident, to be instantaneously self-acting.

(3) The brakes to be put on and taken off (with facility) on the engine and every vehicle of a train.

(4) The brakes to be used in daily working.

(5) The material employed to be of a durable character, so as to be easily maintained and kept in order.

On looking through the Board of Trade returns on continuous brakes for the six months ending June 30, one sees that over two-thirds of the failures of the Westinghouse automatic are due to burst hose pipes alone, and therefore not failures of the brake itself, but of faulty inspection and bad material. We would like to hear of experiments being made with a stronger and more durable material, so as to resist the destructive action of the oil and tallow, of which such a large quantity is used on railways. Could this improvement be effected, we are convinced the number of miles run per failure would immediately vastly increase, leaving the automatic vacuum brake far behind. Of failures of the triple valve to act we find fifteen reports, causing a very trifling delay to the trains. The air-pump is reported with eleven failures, and the driver's brake-valve has no failures recorded against it. When we consider the enormous mileage of 15,505,447 miles run by trains fitted with the Westinghouse automatic for the six months ending June 30, we cannot help being astonished at the freedom from failure of the different parts, and the general efficiency of the apparatus.

Much has been written about the failure of the simple vacuum brake in the Penistone accident on the Manchester, Sheffield, and Lincolnshire Railway, the disaster being attributed by some to the brake failure alone. Certainly, had the train been fitted with the Westinghouse automatic, the brake power on each vehicle would have remained intact, no matter how many couplings broke: but at the same time the fact seems to have been overlooked that the train had no permanent way to run on, since the engine broke up the chairs as it advanced, and the question remains, How would the train have been affected, having nearly all the wheels locked by the brake, and running over sleepers alone? Perhaps the train would not have travelled so far before going over the embankment; but we think the disaster would have been equally serious, each vehicle becoming detached by the sudden application of the brake, the couplings breaking on account of the violent jerks in passing over the sleepers, the curve tending to throw the vehicles over the embankment. As an example of the life-saving qualities of an automatic brake in an accident, we think the Penistone disaster would have been a poor specimen.

The question of automatic *versus* simple brakes, both pressure and vacuum, is now fairly before the public, and the policy of the Board of Trade seems more apparent every day. It would not be wise on their part to enforce the adoption of any particular patent brake, for a better one may any day be discovered, but the Board may fairly insist that their conditions as to the qualities of any brake adopted by any Company should be complied with, and, if necessary, enforced by Act of Parliament.

THE GALVANOMETER OF D'ARSONVAL AND DEPREZ

GALVANOMETERS of innumerable kinds abound, and each form has some special merit which renders it useful for certain restricted services. The old astatic instrument of Nobili is still preferred by many to the more modern mirror galvanometer of Sir W. Thomson because it requires no lamp, and can be used without darkening the room. The tangent galvanometer still holds its own in the testing-room for simple tests; and the lineman's detector is still indispensable on the score of its portability. For commercial purposes, where strong currents and steady potentials have to be measured, the newer ampere-meters and volt-meters have displaced the older forms of instrument. But still there is no best galvanometer of universal adaptability, even the Siemens "universal" galvanometer being too clumsy to meet with general favour.

For the purposes of the private laboratory a galvanometer is desired which shall be sensitive, yet accurate in its indications, capable of being used for measuring currents of all kinds, weak and strong, and of measuring differences of potential from the thousandth of a volt to a thousand volts. It ought to be capable of being used in broad daylight; of being rapidly read off; and it ought also to be independent of external magnetic disturbances. The annoyances which arise from the last two causes when working with sensitive galvanometers are only too well known. The needle of the instrument once deflected continues to oscillate perhaps for half a minute, perhaps longer, causing vexatious delays, and when perhaps it has settled down at last to zero, some person in the next room moves a piece of iron—a poker, a penknife, or some other magnetic object—causing the zero of the instrument to change. An aperiodic dead-beat instrument, not subject to external magnetic forces, would be a boon indeed.

A galvanometer which, without being absolutely perfect, goes very near to fulfilling these desirable conditions has lately been put into the hands of electricians by M. Carpentier, of Paris, successor to the well-known Ruhmkorff. It is the invention of M. Marcel Deprez as modified and improved by Dr. d'Arsonval. The many novel features which it presents would of themselves justify its description in the pages of NATURE; and the general excellence

of its performance, of which the writer of these lines can personally testify, is already widely acknowledged.

The main peculiarity of the new instrument lies in the fact that, whereas in almost all galvanometers there is a fixed coil and a movable magnetic needle, in this galvanometer the coil is movable and the magnet—no longer a mere needle but a substantial compound horse-shoe of steel—is fixed. Fig. 1 represents the instrument itself. The steel magnet, made of three thin horse-shoes each magnetised as strongly as possible, is firmly fixed to a metal base, with its poles upwards. Between the poles hangs the coil, rectangular in form and extremely light, held in its place by a thin silver wire above and another thin silver wire below. This coil is made by winding on a rectangular core, which, after the strands have been cemented and bound together, is removed, leaving the wire only. It weighs only a few grains. To reinforce the magnetic field a small cylinder of soft iron, small enough to lie in the hollow of the suspended rectangular coil without touching it, is placed between the poles and is rigidly supported from behind. The coil s then free to turn in the very narrow space between the

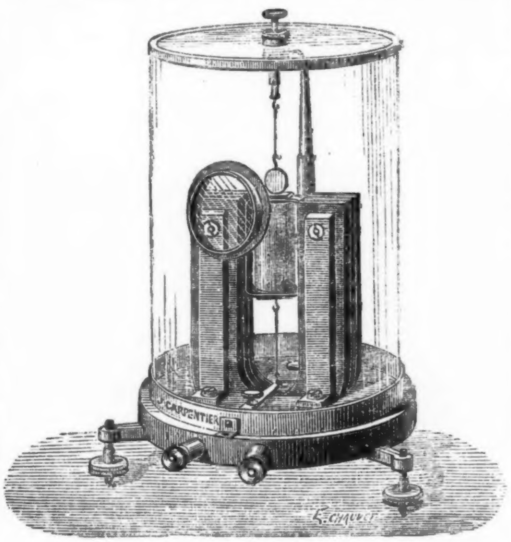


Fig. 1.

iron core and the external magnet-poles; and it need hardly be added that this contrivance produces a very intense magnetic field. The current is led in by one of the silver suspension-wires, and leaves the coil by the other. So far the arrangement precisely resembles that adopted in the well-known "siphon-recorder" of Sir W. Thomson, invented twenty years ago for the purpose of cable-signalling. A small mirror of 1 metre focus is affixed to the suspended coil; a brass spring at the bottom keeps the suspending wires adequately stretched; and a screw-head at the top of the instrument serves both to regulate the tension in the wires and to let the coil down, to a position of rest on the central iron cylinder, whenever the galvanometer is to be dismounted for removal to a distant place. The resistance of the coil is about 150 ohms in the ordinary pattern of instrument. As there is no suspended needle, no external magnetic forces affect the zero of the instrument; and, since the position of the coil is determined solely by the elasticity of the suspending wires and the magnetic action of the fixed magnet on the current in the coil, it can be used in any position, and is independent of the earth's magnetic field. It can even be placed quite near to a dynamo-machine. The intensity of the magnetic field in which the coil is situated is such that whenever the galvanometer-circuit is closed—even through a considerable resistance—the motion of the needle is dead-beat. It takes less than *one second* to come to rest at its final position of deflection, and when it returns to zero it does so with the most complete absence of oscillations. The spot of light on the scale never oscillates so much as 1 millimetre over the zero on releasing the galvanometer-key.

The optical arrangements adopted by M. Carpentier are shown in Fig. 2. The instrument is set with its three levelling screws in three V-grooves in a convenient bed-plate. Opposite it is set a semi-transparent scale of celluloid, 50 centimetres in length, graduated in millimetres. The light is provided by a single wax candle held in a holder like a carriage-candle, which also carries a paraboloidal mirror back. This candle is set so that its light falls upon a small adjustable plane mirror fixed to the back of the scale. This mirror reflects the ray upon the small mirror of the galvanometer, but as it passes beneath the scale it traverses a square aperture across which a thin wire is stretched vertically. To see the spot of light the observer stations himself in front of the scale, so as to see the light coming through the strip

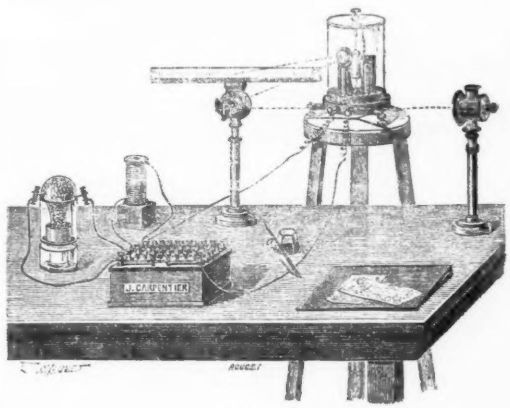


Fig. 2.

of celluloid. He sees a bright patch about 1 inch square having a single sharply-defined black line—the image of the aforesaid wire—down its middle. This patch of light and the central line are perfectly visible in broad daylight, but cannot be well seen by more than one observer at one time. The adjustment of the lamp and scale is a simple matter; and light from any lamp in the room—an overhead gas-light for example—may be used instead by turning the adjustable mirror to the proper angle.

When set up without any shunt, this galvanometer will show a deflection of 1 millimetre on the scale for about 1/100,000,000 of an ampere of current: but the sensitiveness differs in different instruments with the construction of the coil, the stiffness of the suspension, and the power of the magnets. Two instances of its application may be given.

The instrument can be applied as a volt-meter to measure the electromotive forces of cells in the manner indicated in Fig. 3. An ordinary reversing-key, K, is connected to the galvanometer, and an adjustable resistance (a Wheatstone rheostat with a thin wire having a range from 1 to 200 ohms is convenient) is interposed as a shunt, S. To calibrate the instrument a standard Daniell cell (E.M.F. = 1·07 volt) is placed at B in circuit with a resistance box. A resistance of 10,000 ohms is unplugged and a reading

is taken of the galvanometer, first to left, then to right, and the shunt-resistance is then adjusted until the scale reading is $53\frac{1}{2}$ millimetres on either side of zero, making a total of 107 millimetres. We then know that a deflection of 1 millimetre right or left will be produced by an electromotive force of 1/200 of a volt. The cell whose electromotive force is to be tested is then substituted at B in place of the standard cell, and readings taken right and left; these are added, and divided by 100, giving the E.M.F. of the cell directly in volts.

To measure currents the same calibration is made with a standard cell. In the circuit of the current to be measured is interposed a wire of some small but accurately-known resistance—for example, a standard 1 ohm, or, for stronger currents, a standard wire of 0·1 ohm. The two extremities of this coil are then connected to the key (Fig. 3), the 10,000-ohm coil being interposed as before. If the current to be measured is 1 ampere, it will, in passing through the standard 1 ohm, produce

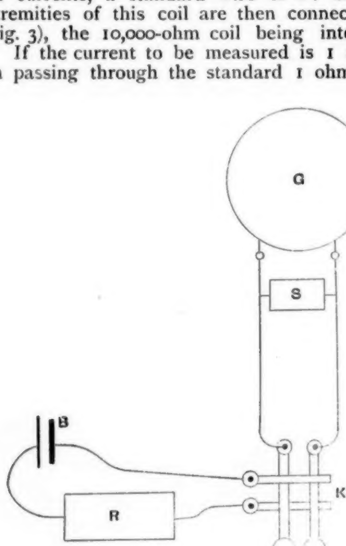


Fig. 3.

between its ends a difference of potential of 1 volt, and this difference of potential will, when readings are taken right and left, give a total deflection of 100 millimetres to correspond to 1 ampere of current. It is not difficult to modify the arrangements so that the galvanometer may measure, on the one hand, millionths of an ampere, and thousands of amperes on the other. We have found the instrument specially valuable for indicating rapid fluctuations of current in experiments on the induction of currents in armature coils when moved in a magnetic field. Its complete aperiodicity and the very small inertia, both mechanical and electrical, of its coil, render it most valuable for such work. The only defect—and that not a serious one—observed in three months of use, is a slight sub-permanent torsion on the suspending wires after taking a large deflection; but the method of taking double readings, first to right, then to left, eliminates any error that might arise from this cause.

THE BASALT-FIELDS OF NEW MEXICO

GEOLOGISTS interested in the history of the younger lava-floods, by which such vast areas both in the Old World and in the New have been deluged, will be glad to know that Capt. Dutton, of the United States Geological Survey, after a careful study of the modern volcanic phenomena of the Sandwich Islands, has undertaken the investigation of the basalt-territory lying in New Mexico, to the east and south of the area already so fully described by him in his Monographs on the Utah plateaux and the Cañon country. It was originally intended that he should have charge of the Survey of the Cascade Range. This arrangement was changed at the beginning of this last season. The Cascade ground was intrusted to his able assistant, Mr. Diller, while Capt. Dutton himself struck southward for a region in New Mexico, which he had long wished to study, from the light which he believed it would throw upon some of the later phases of volcanism in the Western Territories. I have received a long letter from him, written in his camp at the San Mateo Mountains, from which, with his permission, I send the following extract for publication in NATURE. ARCH. GEIKIE

Our wonderful Plateau Country we have known only in part, and the portion we have studied most is situated upon the western and northern side of the Colorado. Numerous geologists have hurried over the southern and south-eastern portion; but so rapidly have they been obliged to move in order to keep pace with the expeditions of which they were mere appendages that very little systematic knowledge could be gained. During the last two years our topographers have made some excellent maps of this region, and everything is ripe for the geologist.

I have described the western and southern portions of the Plateau Country as being very sharply defined in a geological as well as in a topographic sense. I think it will in great part prove to be equally well-defined in the south-eastern portions. Already it is clear to me that the Rio Grande River constitutes a portion of that boundary in this territory. Everywhere within range of my present field the strata characteristic of the Plateau Country rise gently from the Rio Grande to the westward. Cliffs, mesas, and terraces, carved buttes, and gorgeous colours are as typical of this region as they are of Utah and Northern Arizona. There is, however, more of the Cretaceous system preserved, and rocks of that age predominate, though the Trias and Permian are magnificently exposed. Indeed, the Vermilion Cliffs of Southern Utah have reappeared here in all their grandeur and glory, with but slight changes of detail.

But the features which are engaging my particular attention at this moment are the volcanic vestiges. This region has long been known under the mysterious name of *Malpais*—mysterious, however, only to those who have not read Humboldt's account of the *malpais* of Old Mexico. All the mesas, or platforms of sedimentary beds, within three or four miles of my camp, are sheeted over with basalt. The lava caps are not ordinarily more than fifty or a hundred feet thick; though just around me, in the very centre or focus of all, it becomes much thicker. In the valley-plains, also, are found many sheets of lava. But while the lavas upon the higher platforms and terraces are ancient, those in the valleys are very young. The centre of the activity has been (so far as concerns my present vicinity) the San Mateo Mountains. This name is synonymous with Mount Taylor, for the "Mountains" consist of a single volcanic pile (11,380 feet) carved into numerous spurs by magnificent gorges. It is a small Etna, built originally by outbreaks from its flanks as well as its summit. But the spread of the lavas from this centre is remarkable. To the north-north-east they reach out in unbroken continuity for forty-five miles, and for eighteen to thirty miles in the other directions. The lava beyond the immediate base of the mountain-cone is not thick. It forms a superficial sheet only on each mesa, or table, with a thickness varying from 50 to 200 feet.

The lava-capped strata have been cut into isolated mesas by subsequent erosion, and gaps of two or three miles sometimes separate one of these outliers from its parent mass.

This lava did not by any means come altogether from Mount Taylor itself, but from many vents scattered around its flanks, or situated miles away from it. These outlying vents are sufficiently preserved in many cases to admit of their complete identification, and they are very numerous. But one of the most charming and striking features consists in the numerous "necks" or "chimneys" which are left standing in the valley-plains beyond the farthest verge of the lava-capped mesas. Some of these are splendid objects. Newberry has depicted similar forms in the valley of the San Juan—a hundred miles or more to the north-west of here—in his admirable account of the observations made in his journey with Capt. Macomb's expedition. But these are even larger and finer, one being nearly two thousand feet high. What perfect testimony this is to the enormous erosion of the country! A child can read and comprehend it.

In the wide valley-plains which lie between the mesas are fresher fields of lava. Some look as if they could hardly be a century old; but my experience in the Hawaiian Islands has taught me that, in a dry country, a basalt-stream can preserve its freshness for many centuries. Still, it is clear enough that these eruptions occurred after hundreds, even thousands, of square miles of strata, overflowed by the older basalts, had been eroded away.

A striking fact in connection with these young basalts is the entire absence of all distinguishable traces of the vents from which they came. A few miles from here, in a broad valley, lies a basalt-field black as Erebus, and the whole circuit of it as accessible as a sheet of paper on a table, or a rug on the floor. There is no cone, no trace of fragmental ejecta, not a single feature in it to indicate the *locus* of eruption, except, however, the fact that the whole field, and the valley in which it lies, has a gentle declivity to the south-east, say forty feet per mile or so: and as the sheet follows the modern slope of the valley, it may be inferred that the vent is situated near the north-west end. There are many other fields of fresh lava, of which the above is sufficiently descriptive. One stream is nearly sixty miles long! Some of them, however, indicate unmistakably their sources in small depressed cones of very flat profiles. Great deluges of basalt have issued from them, flowing away for many miles, and spreading out five or six miles wide.

No fragmental ejecta (scoria, lapilli, &c.) have been found in connection with these young eruptions. But on Mount Taylor are numerous parasitic cinder-cones, of small or moderate dimensions, formed during the period of the eruption of the older basalts. The quantity of this fragmental material, however, is relatively very small.

The appearance of the young basalts is much like the rougher lava of Mauna Loa, called "aa" in the Hawaiian Islands. This is the typical *malpais* of this region. All the lava thus far seen is apparently basalt, though some of the older may prove to be andesitic when critically examined. There is little variety in it. It now appears that, all along the western, southern, and south-eastern rim of the Plateau Country is a marginal belt characterised by basaltic eruptions. I have identified two ages of eruption, both here and in South-West Utah. In the latter region I have associated these two periods of eruption with two periods of general upheaval of the plateaux. Whether the same will prove to be so here remains to be seen.

But it is getting dark, and I must close. We go to bed and get up with the chickens in this country.

C. E. DUTTON

NOTES

A MEETING of members of the University and others, to promote the objects of the Marine Biological Association, will be held at Cambridge on Saturday next, the 29th inst., in the Lecture-Room of Comparative Anatomy, the use of which for this purpose was granted to Prof. Newton by grace of the Senate on Thursday last. The Vice-Chancellor of the University (Dr. Ferrers, F.R.S., Master of Gonville and Caius College) has kindly undertaken to preside; and Prof. Moseley (the Chairman of the Council of the Association), Prof. Lankester (its Secretary), and Prof. Bell, of the British Museum and King's College, London, are expected to attend and set forth the aims and needs of their deserving body. The chair will be taken at three o'clock in the afternoon, and the proceedings (the details of which are being arranged by Mr. J. W. Clark, Superintendent of the Museum of Zoology and Comparative Anatomy, and Mr. Sedgwick, University Lecturer in Animal Morphology) are likely to be full of interest. The same evening the anniversary dinner of the Cambridge Philosophical Society will be given in the hall of Peterhouse, on the special invitation of the Master and Fellows of that ancient college, the newly-elected President of the Society, Prof. Foster, Sec. R.S., in the chair.

THE German Government has granted another sum of 7500*l.* for the scientific investigation of Central Africa, and 1900*l.* for the working out of the materials collected by German Polar expeditions.

THERE seems to be no end to the works of the highest value issued from the American *Nautical Almanac* Office. This week we have received a paper on "The Motion of Hyperion—a New Case in Celestial Mechanics," by Prof. Simon Newcomb, and another on "Lunar Inequalities due to the Ellipticity of the Earth," by Mr. G. W. Hill.

AT the first meeting of the new session of the Society of Arts held on November 19, Sir Frederick Abel made some feeling and pregnant remarks on the loss that not only the Society of Arts, but the whole scientific world, had sustained by the sudden and unexpected death of Sir William Siemens. In the course of his address Sir Frederick Abel said:—"It will be in the recollection of many whom I am addressing that, while Sir William Siemens was an ardent and successful labourer in the advancement of electric lighting, he also maintained the view that gas would continue to hold its own as the poor man's friend. The name of Siemens is associated with the origination of a great advance in the application of gas to the brilliant illumination of open spaces; but it must also be conceded that many streets and public places in London and the provinces bear evidence that even such simple modifications in the arrangement of old forms of gas-burners as have been introduced by Sugg and others have restored to gas some of its original prestige, and that, especially in towns where fogs are periodically prevalent, gas is now by no means wholly eclipsed by electricity as an open-air illuminant."

LAST week we announced the death of Dr. Wright of Cheltenham; to-day we have to make known that another of the lights of English geology has passed away. Mr. R. A. Godwin-Austen died at his residence, Shalford House, Guildford, on the morning of the 25th inst., after a long, but happily not a painful illness. He has for so many years lived retired in his country home that the younger generation of geologists has hardly known him personally. But his papers are classical in the literature of English geology, and long ago marked him out as one of the most philosophical of all the geological writers of this country.

MR. JAMES BUCKMAN, formerly one of the Professors at the Royal Agricultural College, Cirencester, and author of a number of geological papers, died at Bradford Abbas, Dorset, on the 23rd inst.

THE death is announced of Herr August Wilhelm Thienemann, the President of the German Society for the Protection of Birds, well-known in ornithological circles by his researches

and works. He died at Langenberg on the 5th inst., aged fifty-four years.

WE regret to announce the death, at Paris, of M. Lartigue, aged fifty-four, a French electrician well known for his system of railway-signalling, which is largely in use on the French lines, and who had latterly held the post of General Director of the French Telephonic Company.

WE regret to learn of the death, at the early age of thirty-four, of M. Henninger, one of the editors of *Science et Nature*. After a brilliant career as a medical student, he was appointed assistant to M. Wurtz in the chair of medical chemistry, as well as professor in l'École municipale de Chimie. He was the author of numerous articles in periodicals and encyclopædias, chiefly on chemistry.

THE permanent Committee appointed by the International Ornithological Congress at Vienna for the purpose, among other tasks, of erecting ornithological stations of observation all over the globe, has addressed the Imperial Academy of Sciences in Vienna with the request that, so far as its sphere of action extends, it would seek out and appoint men, able and willing to undertake that office, to make regular observations, each within his own particular district, respecting the birds he finds there, their flight, incubation, mode of life, &c., and report them yearly (in the first quarter of the calendar year) to the Secretary of the Committee. The observations so collected will appear, each contribution being under the name and responsibility of the contributor, and will be scientifically digested and embodied by eminent experts. It is hoped that by these means many points hitherto dark in our knowledge of birds will be cleared up, and science generally be extended and enriched.

ADMIRAL VON SCHLEINITZ has resigned the presidency of the Berlin Gesellschaft für Erdkunde, and has been replaced by Dr. W. Reiss. At the last meeting of this Society it was stated that there are now four Polar expeditions in preparation, of which one will start for the Antarctic regions. The African traveller, Dr. Aurel Schulz, has started on a journey across Africa from east to west, by way of the Zambesi River and the Victoria Falls. Lieut. Schulz, the leader of the German African expedition, reports from Cameroon that the joy of the German colonists there is most intense in consequence of recent political events.

THE speeches delivered at the sittings of the Universal Prime Meridian Congress at Washington will be published *in extenso* in French, having been translated under the superintendence of M. Janssen, who was specially appointed by the Congress for that task.

THE collections made by the Polar traveller, Capt. Jacobsen, by order of the Berlin Museum, on his American tour, are now on view at the Royal Ethnographical Museum at Berlin. That part of the collections which was obtained from Alaska territory, consists of some 4000 objects, collected among various Esquimaux tribes and among the Ingalik Indians living on the Yukon River. Most of the objects in question closely resemble those dating from the Stone Age, consisting principally of stone, bone, horn, shell, or wood.

THE expedition of the German travellers, Dr. Clauss and Herr von den Steinen, who undertook to investigate the tributaries on the upper right bank of the Amazon and Xingu Rivers, starting from Paraguay and Cuyaba, have successfully accomplished this task, and safely arrived at Para at the end of October. The Brazilian Government, and especially Senhor Batovi, the Prefect of the province of Matto Grosso, have supported this scientific undertaking in a praiseworthy manner.

THE Commission of the Centennial Exhibition for 1889 have already held several meetings with the object of determining upon a site for the Exhibition. As many as four places are competing for this honour, exclusive of the Bois de Boulogne, which was mentioned in connection with this matter some months ago.

THE excellent "Monthly Reference-Lists," which are printed by Mr. W. E. Foster of the Providence Public Library, should be watched, says *Science*, by scientific men as well as by literary readers. The August number (vol. iv. No. 8) contains a handy index to articles on earthquakes—theories and observations—which was suggested by the shock of August 10, 1884. In judging of the list of memoirs and articles which are cited, the reader should remember that it is prepared for popular reading, and not as an index for the seismologist, nor even for the physicist. The second part of the same number is devoted to the early English explorations of America.

TELEPHONIC service between Brussels and Antwerp was opened on October 20, the wires being used both for telegraphing and telephoning. The Belgian Government intends establishing telephonic connection between Brussels and Liège, Verviers, Mons, Ghent, Charleroi, and Louvain.

AMONG the awards given by the jurors at the National Italian Exhibition we notice a gold medal granted to Signor Ragona, Director of the Modena Observatory, for a complete set of astronomical, meteorological, and magnetical instruments designed by him and executed under his personal supervision.

IN a recent number of the *Revue Scientifique* General Faidherbe draws the boundaries of the large section in the north-west of Africa in part already fallen, in part about to fall, under French control. In the beginning of April this year the French flag was floating from the fort of Bammakoo on the banks of the Niger, and on September 11 a French steamer had made a run down that river from Bammakoo to Koulikoro, bound for Timbuctoo, 300 miles lower down. Altogether, the French have at present the command of the Niger from Bourré to Boussa, some 700 leagues of water-course. From the North of Africa, again, a French railway runs from Arzen to Mécheria, and in a few years more will be continued to Imsalah. But Imsalah is already connected with Timbuctoo by the caravan routes which, under French protection, must become much more important. From Porto Novo on the Gulf of Guinea, moreover, the French cannot but push to Boussa on the Niger, and so complete their commercial route from the Mediterranean to the Gulf of Guinea.

WE have received the Catalogue of the Natural History Collections of the Albany Museum, Grahamstown, Cape of Good Hope, and have much pleasure in observing how considerable the collection already is in specimens both native and foreign, especially birds. For the rest we can only join heartily in the hope expressed by the zealous curator in the preface, that the present inventory of natural history treasures in the young colony will stimulate able friends, at once of the colony and of natural science, to add to the stock and so promote the benign study of Nature in a part of the world not without its share of political troubles. We expect that the promised list of botanical specimens in the herbarium will do justice to the botany, at least, of the South of Africa.

ON the eastern coast of Schleswig the experiments to establish oyster-beds are being actively pursued, under the direction of Prof. Möbius, who is an authority on the subject. Quantities of young American and Canadian oysters have been brought over, and are being "sown out" during favourable weather. The experiments made last year have, so far, not been attended with satisfactory results.

THE organisation of the Pneumatic Postal Service will be completed on December 15 next for the whole of Paris. This great work, costing more than a million francs and involving over 60,000 metres' length of pipes, was inaugurated by M. de

Couchy, who, seventeen years ago, under the Empire, was Director of the French Telegraphs. The charge for carrying a letter to any place within the fortifications has been fixed at 3*d*. The two extreme points in the service are about 11,000 metres apart, and the time required for the delivery of a letter to the remotest place in the most unfavourable circumstances, and including its conveyance from the nearest station, will be within one hour.

THE Scientific Exhibition at Paris, always held on the occasion of the grand *soirée* given by Admiral Mouchez, Director of the Paris Observatory, will this year be under the management of the French Electrical Society, and its exhibits will therefore be confined to objects relating to that branch of science.

PROF. MELL, Director of the Alabama Weather Service, announces, in *Science*, that through the liberality of the Chief Signal Officer, and of several railways, daily weather-signals, predicting changes of weather and temperature, will be displayed at over one hundred telegraph-stations in that State. The predictions will be received by the Director at an early hour every morning from the Signal Office in Washington, and then promptly distributed along the railways. By paying for the cost of the signal-flags (about six dollars), any town or telegraph-station will receive free telegraphic warning of the daily weather changes. Only about five minutes are required to set the flags. A similar system has been for some time in operation in Ohio and in part of Pennsylvania, and it will doubtless have further extension.

THE Commander-in-Chief of the French army in Tonquin has given orders to have a meteorological observatory erected in Haiphong, the chief port in the delta of the Red River, to serve as a basis for a network of meteorological stations with which it is intended to cover eventually the whole of Annam and Tonquin, and which will be in telegraphic communication with the observatory in Hong Kong.

THE series of illustrations of the methods and stages of instruction in handicraft and technical training contributed by the Austrian Government to the Health Exhibition is stated to have been purchased by the Japanese Government from the Technological Museum at Vienna. The Japanese authorities have also made numerous exchanges with the representatives of other countries exhibiting at South Kensington.

THE additions to the Zoological Society's Gardens during the past week include a Common Seal (*Phoca vitulina*) from British Seas, presented by Mr. James Wyat; two Barred Doves (*Geopelia striata*), three Eastern Turtle Doves (*Turtur meena*) from Java, presented by Mr. Emil Berg; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, deposited; a Red-throated Amazon (*Chrysotis collaria*) from Jamaica, a Red-tailed Amazon (*Chrysotis erythrura*) from Brazil, three Blue Snow Geese (*Chen cærulescens*) from Alaska, purchased; a Bernier's Ibis (*Ibis bernieri*) from Madagascar, received in exchange.

OUR ASTRONOMICAL COLUMN

THE ECLIPSE OF THUCYDIDES, B.C. 431, AUGUST 3.—There has been much discussion from time to time with reference to the solar eclipse recorded by Thucydides in the first year of the Peloponnesian war, and long identified as that which occurred on August 3, B.C. 431. We are told, "the sun was eclipsed after midday, and having assumed a crescent form, some of the stars having also appeared, it again became full-orbed." This eclipse was not total, as has been frequently stated, but narrowly annular. Dr. Hartwig in 1859 calculated the circumstances according to the solar and lunar tables of Hansen, and his results were published, with those applying to other eclipses mentioned by Thucydides, in No. 1203 of *Astronomische Nachrichten*. The greatest phase, by his calculations, falls at 5h. 9m. mean time at Athens, and the magnitude of the eclipse is 0·75, rather small, it will be considered, for stars to have been brought into view. But, when all the conditions of the case are borne in mind, it would appear quite possible, to speak within bounds, that Hansen's longitude of the moon may require at that epoch a correction which would suffice, with the rapid descent of the central line in latitude, to cause a great eclipse at Athens, leaving the sun of crescent form, as Thucydides reports, but with the crescent very narrow. In such a climate bright planets and stars might well have been discerned. Venus was westward at an altitude of some 35°, Mars would be near the western horizon, Jupiter had set, while Saturn was near the meridian at an altitude of something like 45°. Of the stars, Spica, Arcturus, Antares, and Vega were in favourable positions for observation.

Sir George Airy informed the writer of these lines some years since that, on the occasion of the partial eclipse of September 7, 1820, he "saw one or two stars" at Cambridge. On calculating the circumstances of the eclipse for that place, it appears the magnitude was 0·88. This is an interesting case in point.

WOLF'S COMET.—A few week's since it was remarked in this column that, according to the first elliptical orbit calculated by Prof. Krueger, this comet would approach very near to the orbit of Jupiter in about 209° heliocentric longitude, and great perturbation was possible early in the year 1875, so that the comet might not have been moving long in its present track. On this subject Prof. Krueger, who has recalculated the elements of the comet's orbit from a much wider extent of observation, expresses himself as follows in No. 2629 of the *Astronomische Nachrichten*:—"In Nr. 782 der NATURE (1884, October 23) ist hierauf bereits aufmerksam gemacht worden; ich hielt indessen damals die ersten Elemente für viel ungenauer, als sie wirklich waren, und glaubte, dass Erörterungen dieser Art noch etwas aufzuschieben seien. Die nachfolgende Rechnung bestätigt indessen die in der NATURE ausgesprochene Vermuthung in überraschender Weise." In fact, Prof. Krueger finds by his new orbit that on May 28, 1875, the comet's distance from Jupiter was less than 0·1 of the earth's mean distance from the sun, and hence it is probable that before the spring of this year the comet may have been describing a very different orbit to that in which it now moves. This, as was before remarked, will form an interesting subject of investigation, when definitive elements have been deduced from a combination of all the observations of the present appearance.

In Prof. Krueger's last orbit, founded on observations to November 7, the period of revolution is 2466·06 days, according to which the comet would have been in perihelion about February 16, 1878, in R.A. 23h. 58m., Decl. + 2°, distant from the earth 2·32, and under such circumstances not likely to have been seen. We subjoin other elements of the orbit:—

Semi-axis major ...	3·5722	Perihelion distance ...	1·5719
,, minor ...	2·9596	Aphelion ,, ..	5·5725
Semi-parameter ...	2·4521	Excentricity	0·559966

MINIMA OF ALGOL.—The following are approximate geocentric Greenwich times of minima of Algol, calculated from elements upon which the later observations of Schmidt have been brought to bear:—

	h. m.		h m.		h. m.
Nov. 27 ...	13 24	Dec. 23 ...	8 45	Jan. 26 ..	18 35
30 ...	10 13	25 ...	5 34	29 ...	15 24
Dec. 3 ...	7 2	Jan. 6 ...	16 51	Feb. 1 ...	12 14
14 ...	18 18	9 ...	13 40	4 ...	9 3
17 ...	15 7	12 ...	10 29	7 ...	5 52
20 ...	11 56	15 ...	10 18		

THE WAVE THEORY OF LIGHT[1]

THE subject upon which I am to speak to you this evening is happily for me not new in Philadelphia. The beautiful lectures on light which were given several years ago by President Morton of the Stevens' Institute, and the succession of lectures on the same subject so admirably illustrated by Prof. Tyndall, which many now present have heard, have fully prepared you for anything I can tell you this evening in respect to the wave theory of light.

It is indeed my humble part to bring before you some mathematical and dynamical details of this great theory. I cannot have the pleasure of illustrating them to you by anything compar-

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D.

able with the splendid and instructive experiments which many of you have already seen. It is satisfactory to me to know that so many of you, now present, are so thoroughly prepared to understand anything I can say, that those who have seen the experiments will not feel their absence at this time. At the same time I wish to make them intelligible to those who have not had the advantages to be gained by a systematic course of lectures. I must say in the first place, without further preface, as time is short and the subject is long, simply that sound and light are both due to vibrations propagated in the manner of waves; and I shall endeavour in the first place to define the manner of propagation and mode of motion that constitute those two subjects of our senses, the sense of sound and the sense of light.

Each is due to vibrations. The vibrations of light differ widely from the vibrations of sound. Something that I can tell you more easily than anything in the way of dynamics or mathematics respecting the two classes of vibrations is, that there is a great difference in the frequency of the vibrations of light when compared with the frequency of the vibrations of sound. The term "frequency" applied to vibrations is a convenient term, applied by Lord Rayleigh in his book on sound to a definite number of full vibrations of a vibrating body per unit of time. Consider, then, in respect to sound, the frequency of the vibrations of notes, which you all know in music represented by letters, and by the syllables for singing, the do, re, mi, etc. The notes of the modern scale correspond to different frequencies of vibrations. A certain note and the octave above it correspond to a certain number of vibrations per second and double that number.

I may explain in the first place conveniently the note called "C"; I mean the middle "C"; I believe it is the C of the tenor voice, that most nearly approaches the tones used in speaking. That note corresponds to two hundred and fifty-six full vibrations per second, two hundred and fifty-six times to and fro per second of time.

Think of one vibration per second of time. The seconds pendulum of the clock performs one vibration in two seconds, or a half vibration in one direction per second. Take a ten-inch pendulum of a drawing-room clock, which vibrates twice as fast as the pendulum of an ordinary eight-day clock, and it gives a vibration of one per second, a full period of one per second to and fro. Now think of three vibrations per second. I can move my hand three times per second easily, and by a violent effort I can move it to and fro five times per second. With four times as great force, if I could apply it, I could move it twice five times per second.

Let us think, then, of an exceedingly muscular arm that would cause it to vibrate ten times per second, that is ten times to the left and ten times to the right. Think of twice ten times, that is, twenty times per second, which would require four times as much force; three times ten, or thirty times a second, would require nine times as much force. If a person were nine times as strong as the most muscular arm can be, he could vibrate his hand to and fro thirty times per second, and without any other musical instrument could make a musical note by the movement of his hand which would correspond to one of the pedal notes of an organ.

If you want to know the length of a pedal pipe, you can calculate it in this way. There are some numbers you must remember, and one of them is this. You, in this country, are subjected to the British insularity in weights and measures; you use the foot and inch and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister, whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes.

I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change, and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform.

I know the velocity of sound in feet per second. If I remember rightly, it is 1089 feet per second in dry air at the freezing-point, and 1115 feet per second in air of what we call moderate temperature, 59° or 60°—(I do not know whether that temperature is ever attained in Philadelphia or not; I have had no experience of it, but people tell me it is sometimes 59° or 60° in Philadelphia, and I believe them)—in round numbers let us call it 1000 feet per second. Sometimes we call it a thousand musical feet per second, it saves trouble in calculating the length of organ pipes; the time of vibration in an organ pipe is the time it takes a vibration to run from one end to the other and back. In an organ pipe 500 feet long the period would be one per second; in an organ pipe ten feet long, the period would be fifty per second; in an organ pipe twenty feet long, the period would be twenty-five per second at the same rate. Thus twenty-five per second, and fifty per second of frequencies, corresponds to the periods of organ pipes of twenty feet and ten feet.

The period of vibration of an organ pipe, open at both ends, is approximately the time it takes sound to travel from one end to the other and back. You remember that the velocity in dry air in a pipe ten feet long is a little more than fifty periods per second; going up to 256 periods per second, the vibrations correspond to those of a pipe two feet long. Let us take 512 periods per second; that corresponds to a pipe about a foot long. In a flute, open at both ends, the holes are so arranged that the length of the sound-wave is about one foot, for one of the chief "open notes." Higher musical notes correspond to greater and greater frequency of vibration, viz., 1000, 2000, 4000 vibrations per second; 4000 vibrations per second correspond to a piccolo flute of exceedingly small length; it would be but one and a half inches long. Think of a note from a little dog-call, or other whistle, one and a half inches long, open at both ends, or from a little key having a tube three-quarters of an inch long, closed at one end; you will then have 4000 vibrations per second.

A wave length of sound is the distance traversed in the period of vibration. I will illustrate what the vibrations of sound are by this condensation travelling along our picture on the screen. Alternate condensations and rarefactions of the air are made continuously by a sounding body. When I pass my hand vigorously in one direction, the air before it becomes dense, and the air on the other side becomes rarefied. When I move it in the other direction, these things become reversed; there is a spreading out of condensation from the place where my hand moves in one direction and then in the reverse. Each condensation is succeeded by a rarefaction. Rarefaction succeeds condensation at an interval of one-half what we call "wave lengths." Condensation succeeds condensation at the full interval of what we call wave lengths.

We have here these luminous particles on this scale,[1] representing portions of the air close together, dense; a little higher up, portions of air less dense. I now slowly turn the handle of the apparatus in the lantern, and you will see the luminous sectors showing condensation travelling slowly upwards on the screen; now you have another condensation; making one wave length.

This picture or chart represents a wave length of four feet. It represents a wave of sound four feet long. The fourth part of a thousand is 250. What we see now of the actual scale represents the lower note C of the tenor voice. The air from the mouth of a singer is alternately condensed and rarefied just as you see here.

But that process shoots forward at the rate of one thousand feet per second; the exact period of the motion is 256 vibrations per second for the actual case before you. Follow one particle of the air forming part of a sound wave, as represented by these moving spots of light on the screen; now it goes down, then another portion goes down rapidly; now it stops going down; now it begins to go up; now it goes down and up again.

As the maximum of condensation is approached, it is going up with diminishing maximum velocity. The maximum of rarefaction has now reached it, and the particle stops going up and begins to move down. When it is of mean density the particles are moving with maximum velocity, one way or the other. You can easily follow these motions, and you will see that each particle moves to and fro, and the thing that we call *condensation* travels along.

[1] Alluding to a moving diagram of wave motion of sound produced by a working slide for lantern projection.

I shall show the distinction between these vibrations and the vibrations of light. Here is the fixed appearance of the particles when displaced but not in motion. You can imagine particles of something, the thing whose motion constitutes light. This thing we call the luminiferous ether. That is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and substantiality of the luminiferous ether. This instrument is merely a method of giving motion to a diagram designed for the purpose of illustrating wave motion of light. I will show you the same thing in a fixed diagram, but this arrangement shows the mode of motion.

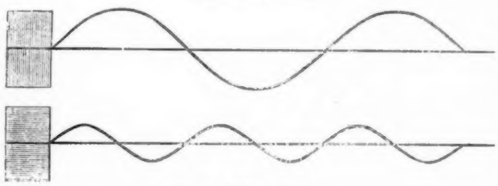
Now follow the motion of each particle. This represents a particle of the luminiferous ether, moving at the greatest speed when it is at the middle position.

You see the two modes of vibration,[1] sound and light now moving together,—the travelling of the wave of condensation and rarefaction, and the travelling of the wave of transverse displacement. Note the direction of propagation. Here it is from your left to your right, as you look at it. Look at the motion when made faster. We have now the direction reversed. The propagation of the wave is from right to left, again the propagation of the wave is from left to right; each particle moves perpendicularly to the line of propagation.

I have given you an illustration of the vibration of sound waves, but I must tell you that the movement illustrating the condensation and rarefaction represented in that moving diagram are necessarily very much exaggerated, to let the motion be perceptible, whereas the greatest condensation in actual sound motion is not more than one or two per cent. or a small fraction of a per cent. Except that the amount of condensation was exaggerated in the diagram for sound, you have a correct representation of what actually takes place in the low note C.

On the other hand, in the moving diagram representing light waves what had we? We had a great exaggeration of the inclination of the line of particles. You must first imagine a line of particles in a straight line, and then you must imagine them disturbed in a wave curve, the shape of the curve corresponding to the disturbance. Having seen what the propagation of the wave is, look at this diagram and then look at that one. This, in light, corresponds to the different sounds I spoke of at first. The wave length of light is the distance from crest to crest of the wave, or from hollow to hollow. I speak of crests and hollows, because we have a diagram of ups and downs as the diagram is placed.

Waves of Red Light.



Waves of Violet Light.

Here, then, you have a wave length.[2] In this lower diagram you have the wave length of violet light. It is but one-half the length of the upper wave of red light; the period of vibration is but half as long. Now, on an enormous scale, exaggerated not only as to slope, but immensely magnified as to wave length, we have an illustration of the waves of light. The drawing marked "red" corresponds to red light, and this lower diagram corresponds to violet light. The upper curve really corresponds to something a little below the red ray of light in the spectrum, and the lower curve to something beyond the violet light. The variation in length between the most extreme rays is in the proportion of four and a half of red to eight of the violet, instead of four and eight; the red waves are nearly as one to two of the violet.

To make a comparison between the number of vibrations for each wave of sound and the number of vibrations constituting light waves, I may say that 30 vibrations per second is about the smallest number which will produce a musical sound; 50 per second gives one of the grave pedal notes of an organ, 100 or 200 per second give the low notes of the bass voice, higher notes with 250 per second, 300 per second, 1000, 4000, up to 8000 per second give about the shrillest notes audible to the human ear.

Instead of the numbers, which we have, say in the most commonly used part of the musical scale, *i.e.* from 200 or 300 to 600 or 700 per second, we have millions and millions of vibrations per second in light waves; that is to say, 400 million million per second, instead of 400 per second. That number of vibrations is performed when we have red light produced.

An exhibition of red light travelling through space from the remotest star is due to the propagation by waves or vibrations, in which each individual particle of the transmitting medium vibrates to and fro 400 million million times in a second.

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to this. Is the negation of infinitude incomprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Can you suppose an end of matter, or an end of space? The idea is incomprehensible. Even if you were to go millions and millions of miles the idea of coming to an end is incomprehensible.

You can understand one thousand per second as easily as you can understand one per second. You can go from one to ten, and ten times ten, and then to a thousand without taxing your understanding, and then you can go on to a thousand million and a million million. You can all understand it.

Now 400 million million vibrations per second is the kind of thing that exists as a factor in the illumination by red light. Violet light, after what we have seen and have illustrated by that curve, I need not tell you corresponds to vibrations of 800 million million per second. There are recognisable qualities of light caused by vibrations of much greater frequency and much less frequency than this. You may imagine vibrations having about twice the frequency of violet light and one-fifteenth the frequency of red light and still you do not pass the limit of the range of continuous phenomena only a part of which constitutes *visible* light.

Everybody knows the "photographer's light" and has heard of *invisible* light producing visible effects upon the chemically prepared plate in the camera. Speaking in round numbers, I may say that, in going up to about twice the frequency I have mentioned for violet light, you have gone to the extreme end of the range of known light of the highest rates of vibration; I mean to say that you have reached the greatest frequency that has yet been observed.

When you go below visible red light what have you? We have something we do not see with the eye, something that the ordinary photographer does not bring out on his photographically sensitive plates. It is light, but we do not see it. It is something so closely continuous with light visible, that we may define it by the name of invisible light. It is commonly called radiant heat; invisible radiant heat. Perhaps, in this thorny path of logic, with hard words flying in our faces, the least troublesome way of speaking of it is to call it radiant heat. The heat effect you experience when you go near a bright, hot coal fire, or a hot steam boiler; or when you go near, but not over, a set of hot-water pipes used for heating a house; the thing we perceive in our face and hands when we go near a boiling pot and hold the hand on a level with it, is radiant heat; the heat of the hands and face caused by a hot fire, or a hot kettle when held under the kettle, is also radiant heat.

You might readily make the experiment with an earthen teapot; it radiates heat better than polished silver. Hold your hands below, and you perceive a sense of heat; above the teapot you get more heat; either way you perceive heat. If held over the teapot you readily understand that there is a little current of air rising. If you put your hand under the teapot you get cold air; the upper side of your hand is heated by radiation, while the lower side is fanned and is actually cooled by virtue of the heated kettle above it.

That perception by the sense of heat, is the perception of something actually continuous with light. We have knowledge of rays of radiant heat perceptible down to (in round numbers) about four times the wave length, or one-fourth the period of visible, or red light. Let us take red light at 400 million

[1] Showing two moving diagrams, simultaneously, on the screen, one depicting a wave motion of light, the other a sound vibration.

[2] Exhibiting a large drawing, or chart, representing a red and a violet wave of light.

million vibrations per second; then the lowest radiant heat, as yet investigated, is about 100 million million per second in the way of frequency of vibration.

I had hoped to be able to give you a lower figure. Prof. Langley has made splendid experiments on the top of Mount Whitney, at the height of 15,000 feet above the sea-level, with his "bolometer," and has made actual measurements of the wave lengths of radiant heat down to exceedingly low figures. I will read you one of the figures; I have not got it by heart yet, because I am expecting more from him.[1] I learned a year and a half ago that the lowest radiant heat observed by the diffraction method of Prof. Langley corresponded to 28/100,000ths of a centimetre for wave length, twenty-eight as compared with red light, which is 7·3; or nearly fourfold. Thus wave lengths of four times the amplitude, or one-fourth the frequency per second of red light have been experimented on by Prof. Langley, and recognised as radiant heat.

Photographic, or actinic light, as far as our knowledge extends at present, takes us to a little less than one-half the wave length of violet light. You will thus see that while our acquaintance with wave motion below the red extends down to one-quarter of the slowest rate which affects the eye, our knowledge of vibrations at the other end of the scale only comprehends those having twice the frequency of violet light. In round numbers we have four octaves of light, corresponding to four octaves of sound in music. In music the octave has a range to a note of double frequency. In light we have one octave of visible light, one octave above the visible range, and two octaves below the visible range. We have 100 per second, 200 per second, 400 per second (million million understood) for invisible radiant heat, 800 per second for visible light, and 1600 per second for invisible light.

One thing in common to the whole is the heat effect. It is extremely small in moonlight, so small that nobody until recently knew there was any heat in the moon's rays. Herschel thought it was perceptible in our atmosphere by noticing that it dissolved away very light clouds, an effect which seemed to show in full moonlight more than when we have less than full moon. Herschel, however, pointed this out as doubtful; but now, instead of its being a doubtful question, we have Prof. Langley giving as a fact that the light from the moon drives the indicator of his sensitive instrument clear across the scale, and with a comparatively prodigious heating effect!

I must tell you that if any of you want to experiment with the heat of moonlight you must compare the heat with whatever comes within the influence of the moon's rays only. This is a very necessary precaution; if, for instance, you should take your bolometer or other heat detector from a comparatively warm room into the night air, you would obtain an indication of a fall in temperature owing to this change. You must be sure that your apparatus is in thermal equilibrium with the surrounding air, then take your burning-glass, and first point it to the moon, and then to space in the sky beside the moon; you thus get a differential measurement, in which you compare the radiation of the moon with the radiation of the sky. You will then see that the moon has a distinctly heating effect.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Professorship of Political Economy will be filled up on Dec. 13. The Higher Local Examinations were held last June at 21 centres, and attended by 960 candidates (chiefly women), a decrease of 27. In Arithmetic the work of most of the candidates was by no means good. Euclid's propositions were well and neatly written out. In some cases attempts were made to improve upon Euclid, but usually with disastrous results. The book-work of Geometrical Conics was fairly done by the few who attempted it, but only one rider out of four was solved by any candidate. Only a few candidates tried Analytical Geometry, and they nearly all did badly. Some very intelligent work was sent up in Algebra and Trigonometry. In Statics and Dynamics the majority of candidates had made but little way. The attempts at Astronomy were few and generally slight. Altogether, in Group C (Mathematics), there were only 140 candidates, of whom 41 failed, 70 obtained a third class, and only 12 attained a first class.

In Political Economy many of the answers were vague and indefinite. In Logic the simpler questions were well answered, and Mill's inductive methods were understood. Of 45 candidates, however, only 2 gained a first class.

In Group E (Natural Science), out of 62 candidates 25 failed, while 5 obtained a first class. In Elementary Chemistry and Physics the answers were mostly unsatisfactory; Elementary Biology was much better done. Very few candidates seemed to connect the definitions of Chemistry with the facts.

In Physiology and Zoology marked improvement was shown in the answers. The principal fault was still the want of personal acquaintance with phenomena that might be easily observed. In Botany the descriptions of plants were fairly well done, and the questions on Vegetable Physiology were attempted with some success by several candidates. No candidate, however, gave a good description of the germination of a seed.

In Physical Geography and Geology the answers were, on the whole, very good, and remarkably free from errors. The one common failing was the absence of good diagrams.

Mr. James Sully, M.A. Lond., has been appointed a member of the Board of Electors to the Professorship of Mental Philosophy and Logic, in place of the late Dr. Todhunter.

Dr. Donald MacAlister has been appointed by the Senate to be an Examiner in Medicine.

MANCHESTER.—At a meeting of the Council of the Victoria University, Owens College, on Friday, November 21, Mr. J. H. Fowler, B.A. (Oxon.) was elected, on the recommendation of the Senate, to a Berkeley Research Fellowship in Zoology. The Platt Physiological Scholarship, which is also for the encouragement of original research, has been awarded to Mr. C. F. Marshall, B.Sc. (Vict.).

SCIENTIFIC SERIALS

Journal of the Anthropological Institute of Great Britain and Ireland, November 1884.—The ethnology of Egyptian Soudan, a timely and important paper, by Prof. A. H. Keane.—Additional observations on the osteology of the natives of the Andaman Islands, by Prof. Flower.—The Kubus, a small tribe in Central Sumatra, by Mr. Forbes.—Notes on prehistoric remains in Antiparos, by Mr. Theodore Bent.—The Deme and the Horde, by Messrs. Howitt and Fison; an attempt to show a resemblance between the general organisation and usages of the Attic tribes and those of the Australian aborigines.—African symbolic messages, by the Rev. C. Gollmer, describing the method in which natives of the Yoruba country send messages to absent friends by means of shells, feathers, corn, stone, coal, sticks, &c.—On the size of teeth as a character of race, by Prof. Flower.—A Hindu prophetess, by Mr. Walhouse.—On certain less familiar forms of Palæolithic flint implements from the gravel at Reading, by Mr. Shrubsole.

THE *American Journal of Science* for November contains:—Mr. Asa Gray's paper on the characteristics of the North American flora, read before the Biological Section of the British Association at the Montreal meeting; also columbite in the Black Hills of Dakota, by Mr. Blake; spectro-photometric study of pigments, by Mr. Nichols; criticism of Becker's theory of faulting, by Mr. Ross Bourne; the difference between sea and continental climate with regard to vegetation, by Mr. Buysman; chemical affinity, by Mr. J. W. Langley; the relation between the electromotive force of a Daniell cell and the strength of the zinc sulphate solution, by Mr. Carhart; a notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, by Mr. Verrill; and a note by Mr. J. D. Dana, on the Costlandt and Struy Point hornblendic and augitic rocks.

Rivista Scientifico-Industriale, October 30.—On the origin of atmospheric electricity, of thunder-storms and volcanic eruptions (continued), by Prof. Giovanni Luvini.—Note on a simple method for determining the velocity of a railway train, by Prof. Steiner.—Note on Bauer's new radiometer, by the Editor.—On the vitality of insects in oxygen, hydrogen, carbonic acid, and prussic acid, by the Editor.

[1] Since my lecture I have heard from Prof. Langley that he has measured the refrangibility by a rock-salt prism, and inferred the wave length of heat rays from a "Leslie cube" (a metal vessel of hot water radiating from a blackened side). The greatest wave length he has thus found is one-thousandth of a centimetre, which is seventeen times that of sodium light. The corresponding period is about thirty million million to the second.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, November 11.—Prof. Flower, F.R.S., President, in the chair.—The election of Horatio Hale, D. H. Talbot, Dr. F. A. Colby, and Mrs. E. A. Smith was announced.—Mr. Francis Galton described the object, method, and appliances of the late Anthropometric Laboratory at the International Health Exhibition, reserving the statistical results, which were not yet fully worked out, for another occasion. He established it to show with how little expense an elaborate course of measurements might be made, and how popular such a system of measurements would be. The result was that 9344 persons passed through the laboratory, each of them being measured in seventeen distinct particulars for the sum of 3*d.*, in a compartment only 6 feet wide and 36 feet long. The popularity of the laboratory was so great that its door was besieged by far more applicants than could be admitted, and many persons made repeated attempts and waited long for their turn, but at last gave up their attempts as hopeless. So many applications have been made abroad and at home for duplicates of the instrumental outfit that it was advisable that any suggested improvements in them should be considered before they became established in use. The present paper was to invite discussion. An identical set of instruments to those used at the Exhibition have been set up by Mr. Gammage, optical instrument maker, at 172, Brompton Road, assisted by Mr. Williams, who, between them, conducted all the measurements at the Healtheries; they make a moderate charge for measuring and keeping a register of the results.—Mr. H. O. Forbes read a paper on the people of the island of Buru.

EDINBURGH

Royal Physical Society, November 19.—Ramsay H. Traquair, M.D., F.R.SS.L. and E., President, in the chair.—The President delivered the opening address, in which, after referring to the loss which the Society had sustained in the death of Dr. J. A. Smith, for many years its secretary, and subsequently one of its presidents, he called attention to the proceedings of last session as showing that the prosperity of the Society appeared not only in the increase of membership and ingathering of fees, but in scientific work accomplished.—Dr. Traquair then proceeded to discuss the subject of "Biological Nomenclature." Having shown the necessity for a nomenclature intelligible to all scientific men as distinguished from the common names of plants and animals, which varied in different countries, he referred to the introduction by Linnæus of the binomial system, under which each form received a generic and a specific name, and to the action taken by the British Association in 1842, and again in 1865, with the view of securing uniformity. Their rules and recommendations had, he said, worked well for the benefit of science, but they had not been in every particular followed by naturalists abroad, while even in this country there were often heard ominous notes of dissent as to their sufficiency for the wants of the science of the present day. They must, however, form the basis for all subsequent attempts to rectify the subject. Proceeding to discuss those rules, he urged the necessity of strict adherence to priority, and said he agreed with the rule that publication should mean the insertion of the description in a printed book, with the addition that such book might be had on sale. He also expressed concurrence in the recommendation which deprecated the propounding of harsh names, but he could hardly agree with the denunciation of what were called nonsense names, that was, names coined at random without any derivation whatever. The difficulty of devising generic names, not preoccupied, was immense: and if a person with a musical ear invented a nicely sounding word of classical form, surely it was as good as some cacophonous "jaw-breaker," whatever its derivation. Touching next on the comparative value of binomirl, trinomial, and quadrinomial systhms, he hardly thought the time had come for any radical interference with the binomial, which, notwithstanding all its defects, had worked so well from the time of Linnæus to our own. While condemning the practice adopted by some writers of coining new English names, he was in favour of appending the common names, where such really existed, to the scientific ones for behoof of the unscientific.—On the motion of Prof. Duns, a vote of thanks was accorded to the retiring President for his address and for his services in the chair.

MANCHESTER

Literary and Philosophical Society, October 7.—A paper was communicated by Alfred Brothers, F.R.A.S., on the pink sun-glow which he had noticed at midday as early as January this year, and again on July 5 and at the end of August. On the evening of October 3 he observed the same phenomenon by clear moonlight, and attributed it, therefore, to our atmosphere, and not to its being a real appendage of the sun, as had been given out.

October 21.—Joseph Baxendell, F.R.S., communicated a note on the visibility of the moon during total lunar eclipses, in which it was sought to show that the visibility in question might in no inconsiderable measure be due to the outer corona, which extended to a much greater distance on each side of the sun than the semi-diameter of the earth as seen from the moon.—Prof. H. E. Roscoe, F.R.S., contributed a paper on the diamond-bearing rocks of South Africa. Two shafts sunk in the Kimberley Mine—one in the "pipe," the other in the shale near it—passed through the following strata:—

(1) "*Pipe*"	
Red Sand	3 feet
Tufaceous Limestone	15 ,,
Soft yellow earthy diamond rock	30 ,,
Soft blue diamond rock proved to	282 ,,
Total excavated ...	330 feet

(2) "*Outside the Pipe*"	
Red Sand	3 feet
Tufaceous Limestone...	5 ,,
Yellow Shale	20 ,,
Black carbonaceous do.	10 ,,
Two thin bands of black dust in Shale... ...	1 foot
Black Shale	236 feet
Dolerite	2 ,,
Total excavated ...	277 feet

The diamonds were found in the yellow and blue "Stuff" along with garnets, mica, bronzite, ilmenite, pyrite, &c., and were separated by washing the broken-up earth in sluices similar to those used in gold-mining. The annual value of the diamonds from Kimberley was said to be 3,750,000*l.*, and the total amount raised since 1870, to reach the enormous sum of 40,000,000*l.* Five different specimens of the strata were then produced and their analyses given.—Notes on envelopes and singular solutions (continued), by Sir James Cockle, F.R.S.

PARIS

Academy of Sciences, November 17.—M. Rolland, President, in the chair.—On the breathing-bags of the *Calao rhinoceros*, by M. Alph. Milne-Edwards. The specimen of the species of hornbill forming the subject of the paper was brought to Paris last summer by M. P. Fauque, head of the scientific mission recently sent to Sumatra by the Minister of Public Instruction. Owing to the peculiar disposition of its breathing apparatus the *Calao rhinoceros* is a remarkably light bird, its weight scarcely exceeding 1500 grms., although it is about the size of a turkey.—On the anæsthetic action of the chlorhydrate of cocaïne, by M. Vulpian. So powerful is this anæsthetic, which is at present the subject of numerous experiments by M. Koller and other physiologists, that an aqueous solution of one part salt of cocaïne and ninety-nine parts of water inserted under the eyelids produces complete insensibility of the conjunctiva and cornea in the human eye. But the effect, obtained in three or four minutes, lasts only a few minutes. Experiments made on the dog, frog, and other animals, have been attended with like results.—Contribution to the study of the deposits of phosphates (lime, iron, &c.), in the Departments of the Drôme, Isère, and other parts of South-East France, by M. P. de Gasparin.—Experimental demonstration of the inversion of the electromotor force produced by the contact of iron and copper at a high temperature, by M. F. F. Le Roux. From the results of several series of experiments, conducted under varying conditions, the author concludes that at about the temperature of 1000° an electric current passing from the copper to the iron heats the point of contact, while cooling it at the ordinary temperature. A knowledge of this fact, now for the first time demonstrated, may affect not only the theory of thermo-electricity, but also that of certain chemical phenomena.—Experiments made as a contribution to the study of the phenomena produced in man by the ingestion of the diarrhœic liquid of cholera into the stomach, by M. Bochefontaine. From these experiments, made on himself, as well as on the dog, guinea-pig, and other animals, the author feels justified in concluding that the reception in the stomach of the diarrhœic liquid containing the comma-bacillus of cholera does not neces-

sarily produce true cholera in man.—On the presence of the biliary salts in the blood of cholera patients, and on the existence of a toxic alkaloid in their dejecta, by M. G. Pouchet. The author, who is conducting a series of important experiments in the Hospital of Saint-Louis, Paris, concludes, so far, that the blood of cholera victims is certainly charged with a proportion, occasionally very considerable, of biliary salts, while their dejecta nearly always possess a strong alkaline reaction.—Letter on the application of the decimal system to the measurement of angles and of time, by the Minister of Public Instruction and the Fine Arts.—On a generalisation of the theory of mechanical quadratures, by M. Stieltjes.—On the reduction of the Abelian integrals, by M. H. Poincaré. It is shown that any system of Abelian integrals always differs infinitely little from a reducible system.—Note on the involution of superior dimensions, by MM. J. S. and M. N. Vanecek.—Note on an equation analogous to Kummer's equation, by M. E. Goursat.—A fresh demonstration of a theory of Jacobi respecting the decomposition of a number into four squares, by M. M. Weill.—On the laws of friction in mechanical appliances in connection with the experiments on the electric transmission of force about to be made between Paris and Creil, by M. Marcel Deprez.—On the construction of prototype standards of the legal ohm, by M. J. René Benoit. The International Conference of 1884 having defined the value of the legal ohm, the author describes some quicksilver standards representing the new unity constructed by him at the request of the Minister of Posts and Telegraphs.—Note on the indices of refraction of crystallised alums, by M. Ch. Soret.—On the chemical constituents of the rain-water that falls in the city of Algiers, by M. Chairy.—Remarks on the combustible carburetted compounds present in the terrestrial atmosphere, by MM. A. Muntz and E. Aubin.—Note on the trifluoride of arsenic, by M. H. Moissan.—On the reaction of ferric oxide at a high temperature on certain sulphates, by M. Scheurer-Kestner.—On ammoniacal ferment, by M. A. Ladureau. The author gives the results of experiments commenced three years ago for the purpose of determining the *rôle* and presence of this substance in Nature.—On the presence of amylase in the leaves of plants, by M. L. Brasse. The author has determined the presence of amylase in all leaves hitherto examined by him, including the potato, dahlia, maize, beetroot, tobacco, poppy, sunflower, &c.—On the employment of the cultivated yeast of wine for stimulating fermentation and shortening its duration, by M. A. Rommier.—Addition to a note on a crystallised pegmatite of chlorophyllite from the banks of the Vizézy, near Montbrison, by M. F. Gonnard.

BERLIN

Physical Society, October 24.—In former experiments with Helmholtz's leucoscope Dr. König had found that, while persons having normal trichromatic eyes saw the two images appearing in the field of vision differently coloured whatever the position in which the Nicol prism was placed, persons with so-called colour-blind or bichromatic eyes, on the Nicol prism being placed in a certain position, saw similar images. In the case of all so-called red-blind individuals the position of the Nicol prism was always the same, and differed from that in which green-blind persons saw like images. The leucoscope was, therefore, an instrument by means of which colour-blindness could be conclusively determined. For the practical requirements of eye-doctors, Dr. König had now so far simplified the leucoscope that it contained only a double prism, a lens, a quartz plate (of 5, 10, or 15 mm. thick), a Nicol prism, and a telescope. With the help of this simple instrument not only did it become easy to ascertain colour-blindness in practice, but it could likewise be determined whether any transitions occurred between red and green blindness. Among fifty colour-blind persons examined by Dr. Köng, he had not found a single case of such transitional form.—Prof. Neesen reported on the resumption of his earlier experiments regarding the influence of magnetisation on the electrical conductivity of fluids. The fluid conductor consisted of two tubes, a longer and a shorter, to which the current was transmitted by means of electrodes exactly alike. The tubes were combined into a bridge, and counterbalanced by the intercalation of metallic resistances. One tube was brought between the armatures of an electro-magnet, and the resistance measured alternately with and without the excited electro-magnet. When the tube was placed equatorially between the magnetic poles, the difference in the balance of the galvanometer was not greater than that produced on the galvanometer by the magnetising current alone (0·3 parts of the scale). With the tube placed in the axial position, on the other hand, the difference in the balance under an excited electro-magnet amounted to about 1 part of the scale, an effect which seemed to demonstrate a positive influence exercised on the conductivity by the magnetism, considering that the electro-magnet employed was not very powerful. It still remains necessary, of course, to determine by special experiments whether this change of resistance does not proceed from the influence exercised by the magnetism on the polarisation of the electrodes.—Dr. Kayser produced the lightning-photograph he had lately shown to the Meteorological Society (*vide* NATURE, vol. xxx. p. 652), and thereby gave rise to a somewhat lengthy discussion on lightning-discharges.—Prof. Eilhard Wiedemann of Leipzig communicated some results of an examination he had made into colloids, the relation of which to water, following up an earlier work on crystals and crystalloids, he determined with respect to their thermal behaviour. Lime on being brought into contact with water swelled, as was known, and that with evolution of heat. On dissolving slacked lime, on the other hand, in a larger quantity of water, heat became latent. Similar relations applied to other organic colloids, such as gelatine, starch, albumen, &c. The expansion of gelatine under heat Prof. Wiedemann found to be quite regular. At the melting-point of the colloids the curve of expansion showed only a very slight curvature convex to the abscissæ of temperature. When Prof. Wiedemann put some gelatine in a test-glass, and put on the top of it some small shot, and further placed a layer of gelatine over that, he saw, after heating, the shot slowly sink through the viscid mass to the bottom. If he now again spread some small shot on the top of the fluid gelatine, he again saw it sink slowly downwards. As soon, however, as it reached the place occupied by the previous shot before it sank to the bottom, its descent became much more rapid, as though the first shot had opened up a channel of lighter consistence in the gelatine which had been originally of the same consistence as the superincumbent gelatine.

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